UNION CARBIDE

BUSINESS CONFIDENTIAL

PLAINTIFF'S EXHIBIT

UC-162

History of BAKELITE

[redacted]

A 13819

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Bakelite is a phenolic molding compound which Union Carbide marketed from 1939 to 1975. The product was manufactured in Bound Brook, New Jersey, and was marketed through distributors to electrical and electronic parts and products manufacturers for molding into such items as switches, switch boxes, radios, and plug-in receptacles. Although Bakelite contained asbestos, the fibers were encapsulated by resin and therefore were not sold in a respirable form. Also, because the compounds were considered modified by a bonding agent, they were exempt from the Federal requirement of printing caution labels on mixtures containing asbestos fibers.

Bakelite was named for Dr. Leo H. Baekeland who studied phenol formaldehyde condensation products from 1905-1909. Dr. Baekeland realized that these products could not be handled in the same manner as the conventional resins of that time. He therefore made two proposals to overcome the difficulties previously experienced in molding phenolic resins. His proposals were (1) the use of a filler to overcome the problem of brittleness, and (2) the use of heat and pressure during molding. Dr. Baekeland announced his discoveries in 1909.

There are two broad classes of Bakelite molding materials: thermoplastic and thermosetting. Each type requires a distinctive molding technique for process into finished molded products. Bakelite polystyrene plastics were first introduced in 1937 for commercial application in the form of thermoplastic molding materials for injection and compression molding. In addition,

Bakelite produced a wide range of thermosetting phenolic molding plastics which were produced by the chemical reaction of phenol, (and its derivatives) with formaldehyde (and its derivatives).

The phenolic molding plastics were notable due to their ability to insulate electrical material while remaining resistant to heat and water. In addition, these plastics were important because of their dimensional stability, electrical insulating qualities, chemical resistance and economy.

The resinoid is the prime ingredient in phenolic plastics, and various fillers are used to accentuate certain properties. Some of the desired characteristics are better molding qualities, greater strength, and better heat resistance.

The most important of the commercial resins result from a reaction between phenol and formaldehyde. The catalysts used in the reactions influence the relative rates of reactions and subsequent shelf life of the finished product. When basic catalysts are used, a one step resin with a limited shelf life is created. In order to create a two step, or a novolak resin, an acidic catalyst must be used. The advantage of this resin is that it possesses a much longer shelf life.

As Dr. Baekeland discovered, through the use of fillers, the phenolic molding material may be strengthened. The type of filler used depends on the final use of the finished molding material. A listing of the fillers often used would include woodflour, cotton flock, asbestos, and other mineral fibers.

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The phenolic molding plastics were divided into four classes: (1) the general purpose phenolics which used a filler of wood and flour, (2) the shock resistant phenolics which used a paper or fabric filler, (3) the special phenolics or the materials designed for specific requirements, and (4) the heat resistant phenolics which contained a mineral filler.

Mineral fillers were found to be particularly useful as additives to the molding materials used for insulating electronic compounds. The reason was that heat resistant phenolics were the most dimensionally stable of the various phenolics.

Asbestos was used as a filler by Union Carbide in its plastics which were to be used as electrical switch boxes, plug-in receptacles, and radio components. Phenolic molding materials produced by Union Carbide which contained asbestos filler were:

BMZ-5250	BMRS-5305
BMM-5303	BMMA-5353
BMMC-2035	BMMA-5440
BMRS-2035	BMMA-5441

Union Carbide Phenolic Molding Materials are all identified by a 3-or-4-letter prefix followed by 4 digits and then the color designation. (See appendix for specifics regarding Phenolic molding material listed.) Union Carbide purchased the Canadian short fiber asbestos which it used from several suppliers over the years. Some of the more frequent suppliers were Rubberoid Company, Johns-Manville Company Ltd., Asbestos Corporation Ltd., and Carey Canadian Mines. In addition, small quantities of Union Carbide's Calidria asbestos were purchased during 1973 for experimental purposes.

A 10823

Although the asbestos filler used in certain heat resistant phenolics was directly responsible for the qualities found so attractive by purchasers of Bakelite molding materials, it also became a hinderance. The customers who have been identified as purchasers of phenolic molding materials which contained asbestos filler include:

Controls Corporation	2035
Kuhn & Jacobs	2035
Hydromatic Division of GM	5303
Chicago Molded Products	5303
Square D	5440
Chicago Molded Products	5440
Dimco Grey	5440
Harry Davis	5440

Products numbered 5250, 5353, and 5441 accounted for small sales to small unidentified customers. Union Carbide possibly sold phenolic molding materials which contained asbestos to Westinghouse and Proctor-Silex.

By the latter part of the 1960's it was becoming apparent to the general public that exposure to asbestos dust was harmful to one's physical health. However, from the day concern for asbestos exposure first manifested itself, protection of employees, both at the work site and through medical examinations, became an important policy of Union Carbide.

HEALTH AND SAFETY MEASURES

As early as 1949, there were safety codes in existence at the Bound Brook plant. As an example of the early controls in effect, in the 1959 revision of the Safety Code, under the heading Respiratory Protection, there was listed a group of jobs on which

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workers were required to wear approved dust respirators if dust control facilities were not available.

In November of 1968, Walker T. Thompson, Head of Phenolic Resin Production, directed the plant's Medical Director, Dr. C. S. McKinley and department first line supervisors Messrs. Ehlbeck, Housten, and others that x-ray schedules had been established for all employees of the Phenolic Resin Department and that such schedules were to be posted. The results of these tests indicated that none of the workers were suffering from what was then termed dust disease of the lungs.

As the Bound Brook plant incorporated more safety precautions it became the duty of every supervisor to afford the maximum protection for all employees. In addition to the use of respirators on certain jobs, other precautions included the checking and sterilization of all masks, the use of special clothing such as chemical resistant gloves and aprons, and prescribed eye protection in certain areas of the plant.

Since the early 1970's the asbestos-handling procedure used at Union Carbide was in writing and was given to all employees who would come in contact with asbestos. In addition, the procedure was always verbally reviewed at least once a year at general safety meetings.

In August of 1972, the Company began providing protective clothing. Coveralls were to be worn in place of cloth overalls, and could only be worn in the production area. At the end of the day, the coveralls were collected and disposed of in polyethylene bags designed to hold asbestos contaminated items.

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In March of 1972, an [illegible] form of safety inspections began at Bound Brook. These new inspections were aimed primarily at determining how well employees were observing good safety practices, as opposed to the more traditional safety equipment and housekeeping types of inspections. As a further safety measure, in 1974 the Company introduced a voluntary medical screening program to its employees.

CONTROL OF ASBESTOS LEVELS

In June and July of 1968, an Industrial Hygiene Survey was conducted because of a growing concern over potential exposure to airborne levels of asbestos. According to the survey results as reported by Leo J. LaFrance, Industrial Hygienist, only a preliminary check was possible since equipment failure required a shutdown and later a fire caused the line to be down for repairs. Further sampling on the second visit was not possible. This survey indicated that the dust level, especially on the third floor of the plant, was probably too high. On October 21, 1968, Walker T. Thompson sent out a directive requiring all mixermen and roll operators working on a unit where an asbestos product was being processed, to wear a respirator. This procedure was to continue until a unit was modified to contain the dust or until it was determined whether a problem existed with the asbestos dust level at that time.

In 1971, an Industrial Hygiene Survey was conducted at the Bound Brook plant. The reason for this study was to continue the industrial surveillance programs which were in effect in various

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areas of the plant. Sample analyses of asbestos fibers were varied when compared to previous tests done but were within the allowable limits. In 1972, the Occupational Safety and Health Administration (OSHA) of the Department of Labor established new limits for the amount of airborne asbestos particles. These limits went into effect on July 7, 1972. The limit established was an eight hour average exposure limit of five fibers per cc of air and was to be lowered to two fibers on July 1, 1976.

In 1972, there were asbestos dust concentrations exceeding the OSHA emergency standard during the preparation of some products. However, the employees exposed to the highest asbestos concentrations were directed to wear respirators at times when they could possibly be exposed to airborne concentrations of asbestos fibers in excess of the new OSHA limits.

In November of 1972, William Bradley, a professional hygienist, visited the plant. Mr. Bradley provided consulting and analytical services to industry and was at the plant to evaluate the plant asbestos and testing programs in the light of current OSHA regulations.

Mr. Bradley had four general comments regarding the handling of asbestos at the Bound Brook plant. First, Mr. Bradley indicated that an OSHA inspector would likely give citations where asbestos was handled in the open without the benefit of a good ventilation system to discharge and dispose of paper bags. Mr. Bradley's second comment was that the accumulation of dust on floors, walls and equipment would coroborate the inspector's view that all handling

[redacted]

A 13827

should be enclosed. The third suggestion was in regard to some minor changes in asbestos dust counting procedures that were not consistent with instructions given by the National Institute for Occupational Safety and Health (NIOSH) in training courses. The last comment which Mr. Bradley had was that some asbestos counts be done by an outside-the-company laboratory in order to give maximum credence to analyses presented.

In December of 1972, J. E. Neff, an employee of Union Carbide, went to the NIOSH course on Sampling and Evaluating Airborne Asbestos Dust, in Cincinnati, Ohio. The purpose of the visit was to compare UCC procedures for sampling and counting asbestos fibers to those used by the people at NIOSH who were responsible for developing the air sampling and fiber counting methods specified by OSHA. In addition, it was the NIOSH labs who did the counting of field samples taken by OSHA inspectors.

In early 1973, a Union Carbide employee went to the New Jersey laboratory of Johns-Manville to compare counting techniques as they pertained to asbestos fibers. By following the counting techniques established by OSHA, the Union Carbide representative was as accurate as the Johns-Manville Industrial Hygienist.

In May of 1974, results of monitoring for airborne asbestos were favorable measuring well below the then existing limit of five fibers per ml, and also below the future 1976 limit of two fibers per ml.

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DEVELOPMENT OF AN ASBE[illegible]PRODUCT

By 1972, Union Carbide realized that it would be desirable to develop an asbestos free molding compound. This decision received added impetus toward the end of 1977 when it was discovered that General Electric was planning to discontinue their manufacture of asbestos containing heat-resistant phenolics by substituting an asbestos free product. In order to combat the commercial pressure for a substitute for asbestos in the phenolics, Union Carbide began development of a suitable alternative.

In October of 1974, the Company was successful in developing an asbestos free phenolic molding material known as BMMA-5440 Black 25 DC. This asbestos free version was a good general purpose molding with an exceptionally smooth surface. In addition, it had good dimensional stability at elevated temperatures and in high humidities. Nevertheless, in 1975 Bakelite Phenolic Molding Resins were dropped from Union Carbide's product line.

CHRONOLOGY OF ACQUISITION OF BAKELITE CORPORATION by UNION CARBIDE CORPORATION

August 11, 1939	-	Reorganization Agreement signed between Bakelite Corporation and Union Carbide and Carbon Corporation.
November 21, 1939	-	Formal transfer of assets between Bakelite Corporation and Union Carbide and Carbon Corporation.
December 31, 1949	-	Merger by liquidation, Bakelite Corporation becomes Bakelite Division.

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February 20, 1951	-	Bakelite Division becomes Bakelite Company, a division of Union Carbide and Carbon Corporation.
November 15, 1958	-	Bakelite Company, a division of UCC becomes Union Carbide Plastics Company.
September 1, 1963	-	The Plastics Division of UCC is dissolved.

A13000

APPENDIX

Nomenclature Description

The following explains the significance of the various letters and numbers:

An example is BMG 5000.

1. Significance of the Letter Prefixes

   First Letter (B) - Designates that the material is based on a phenol-formaldehyde resin.

   Second Letter (M) - Designates that the material is used for molding.

   Third Letter (G, M, or R) - Designates the type of granulation in respect to particle size and content.

   Fourth Letter. In most instances designates a minor change in the formula, new product, or product specifications.

2. Significance of Numerical Designation

   First Number - Designates the type of phenol-formaldehyde resin upon which the compound is based, e.g., 5 and 7 designate a two-step resin system; 2 designates a one-step; 0, 8, or others designate the use of one or more special resins.

   The Last Three Numbers - These are used to designate the specific compound.

A13831

Description of Powder Properties

BAKELITE Phenolic Molding Materials are supplied in several different granulations intended for optimum performance in the various molding processes.

BMG - This is the finest of the three granulations supplied. It is recommended particularly for applications where preforms are used.

BMM - This granulation is manufactured with fewer fines. It is recommended primarily for automatic powder loading. A DC designation indicates that the material has been specially processed to remove fine particles of smoke.

BMRS - Granulation and formulation for screw preheating, particularly in-line injection molding. BMRS materials are normally processed to a DC granulation.

Description of Union Carbide Produced Products Containing Asbestos

BMM-5303 is a low-dust, two-step material formulated for appliance and electrical insulation parts requiring heat resistance and good dimensional stability. It is especially recommended for mechanical automotive applications.

BMMC-2035 is a one-step mineral filled phenolic material recommended for iron handles and other appliance parts requiring a combination of heat resistance and good wet-dry performance.

BMRS-2035 is a one-step mineral filled phenolic material recommended for iron handles and other appliance parts requiring a combination of heat resistance and good wet/dry performance.

A 03932

BMMA-5440/5441 is a wide latitude, general purpose compound which molds with an exceptionally smooth surfaces and has better dimensional stability at elevated temperatures and in high humidities than counterparts in the same specific gravity range. It is particularly well suited for decorative appliance parts, and can be used for electrical and functional parts requiring good dimensional stability.

Since BAKELITE products are no longer produced, a product description was not available for BMZ-5250, BMRS-5305 and BMMA 5353.

A 0303 [redacted]

William R. Bradley and Associates

ENVIRONMENTAL HEALTH CONSULTANTS

[illegible] ROAD • TENAFLY, N. J. 07670

[illegible] M. Swalm - 567-7929

DEC - 1 1972

To (Name) Mr. D. R. Albright
Division Chemicals and Plastics
Location Bound Brook, New Jersey

Copy to Mr. R. W. Cope - SC
Mr. R. A. DeCoudres - BB
Mr. J. L. Goodson - BB
Mr. A. R. Grover - BB
Mr. N. L. Ketcham - SC
Mr. C. F. Martino - BB
Dr. C. S. McKinley - BB
Mr. R. A. Rimicci - BB
Mr. F. A. Schillinger - BB
Mr. J. M. Swalm - BB
Mr. J. P. Zuccarelli - BB

November 28, 1972

[illegible]ration

[illegible]rsey 08805

Re: Environmental Health Consultation

Dear Mr. Neal:

On November 13, 1972, the writer met with you and Mr. R. W. Cope at the Bound Brook plant for a consultation on environmental health matters, mainly with respect to asbestos. A visit was made to Department 014 at the third floor charging stations for asbestos flock, phenolic resin and other ingredients in the various formulations. A fifteen-minute small-impinger air sample was collected for asbestos during the cutting and dumping of eight bags of asbestos flock, and the handling of the empty bags. The asbestos concentration in the breathing zone area of the operator was determined to be 14.1 fibers per cc of five or more microns in length. As you know, this concentration exceeds the former threshold limit of twelve fibers per cc, and the newly-adopted federal and industrial hygiene standard of five fibers per cc. The operator was observed to be wearing an approved-type respirator against asbestos dust.

Observation of the handling of asbestos bags at other dumping stations on the same floor disclosed that all charging hoods are ineffective in design for the handling of asbestos. Asbestos can be handled successfully without contamination of the work environment when the clean and unbroken bag is placed within a complete hood enclosure of bench level type design, which is equipped with both lateral and down draft type mechanical exhaust ventilation. This ventilation should produce 125 feet per minute velocity across the face opening of the booth. The bag can be slit across a cutting knife so that the slit is crosswise at the middle of the bag. The two ends of the bag can be raised for emptying. A side opening within the hood enclosure should be provided to push the empty bag across the bench level and into a large plastic bag container. The empty bags can then be removed from the plant in a closed

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A10334

plastic bag.

Examination of two millipore filters and slide preparations that you submitted to me, has been made. The millipore filter, sample #4, and the micro slide, sample #5, have been analyzed. In each, asbestos found was 10.2 fibers per cc of five microns or greater in length. Millipore filter #6, and micro slide #7 were examined. The asbestos fiber count for those two samples was each 9.8 fibers per cc of five microns or greater in length.

While asbestos can be handled safely in industrial production, the material has been listed by the Occupational Safety and Health Administration as hazardous, and is one of their number one target inspection priorities. The thinking at the National Institute of Occupational Safety and Health, who are setting increasingly more restrictive environmental health standards, is that eventually the threshold limit for asbestos dust will be two fibers per cc. This thinking is based upon that of some of their consultants, who feel that no asbestos should be used in industry.

Although you can manufacture and ship the product containing asbestos without Carbide personnel exposure, such products are becoming suspect in the hands of customers. To offset this fear it is advisable to have independent studies conducted in your customer's plants whether or not such fears exist, and prior to OSHA inspections, if possible. You may recall that this Customer Service technique was undertaken prior to the sale of the toxic organic phosphate insecticides, in order to lessen the risk for both the seller and the customer. It was my suggestion to you that consideration be given to using a substitute in place of asbestos in your product.

I would strongly recommend that you require your asbestos flock shipper to pack asbestos bags in cardboard containers, and anchored to shipping pallets. This has been required of your shipper by other of their customers. An excessive number of broken asbestos flock bags were observed on the charging floor at your plant. The observation of such broken bags, with asbestos dust on the floor and on the bags and pallets, would be of great concern to an OSHA inspector.

It was my pleasure to meet with you and Mr. Cope at your plant.

Very truly yours,

W R Bradley

William R. Bradley

WRB:lw

A13835

UNION CARBIDE

INTERNAL CORRESPONDENCE

UNION CARBIDE CORPORATION

270 PARK AVENUE, NEW YORK, NEW YORK 1001

To (Name) Bonding & Elastomer Materials
Division Salesmen
Location
Floor Number

Date October 17, 1974

Originating Dept. Bonding & Elastomer Materials

Floor Number 32nd Floor

Answering letter date

Subject Phenolic Molding Materials
BMMA-5440 Asbestos-Free

Copy to Messrs. M. Bilancetti
G. L. Brode
G. L. Casiello
W. K. DeFaber
J. W. Demaree
R. F. Dickhaut
R. G. Hess
S. J. Hull
K. J. Hutchinson
R. P. Koehler
B. Letizia
R. T. Marold
L. L. Maycock
V. J. Mitzen
R. J. Ricciardi
F. W. Wurtzell

1) WAK – for your info. We generate the data for updating standard product

2) RJM/RSS – info/product file

Attached is a Data Sheet for the asbestos-free version of BMMA-5440.Black 25 D.C. which may be copied and given to customers currently using the standard BMMA-5440. Printed sheets will be made available for the Data Book towards the end of 1974. It should be noted that the asbestos version is slightly inferior in respect to electrical properties and ASTM deflection temperature. However, these are not expected to be significant in most applications.

Samples of the new 5440 are undergoing tests for yellow card approval at Underwriters Laboratories and it is expected that results will be available by the end of November or early December.

To date all customers have reported favorably on the performance of the new 5440. Again you are asked to do everything possible to expedite the changeover.

Data Sheets for BMRS-5440 will be issued as soon as sufficient data has been obtained to develop reliable figures.

P.B. Potter/map
P. B. POTTER

[redacted]

PBP/map
Attachment

A 3536

Union Carbide Plastics Division of Union Carbide Corporation reserves the right to alter the formulation and to discontinue the production of this product at any time.

'BAKELITE' PHENOLIC MOLDING MATERIAL

BMMA-5440 Black 25 D.C

DESCRIPTION:

BMMA-5440 Black 25 D.C., without asbestos, is a wide latitude, general purpose compound which molds with an exceptionally smooth surface and has good dimensional stability at elevated temperatures and in high humidities.

General Purpose

October 1, 1974

PROPERTY	SPECIMEN	TESTING METHOD	UNIT	TYPICAL VALUE
Specific Gravity	...	D792	...	1.39-1.43
Bulk Factor	...	D392	...	2.4 Max
Pourability	...	D792	seconds	-
Molding Shrinkage	1/8 x 4 in. disk	D955	inch/inch	0.003-0.006
Izod Impact Strength	1/2x1/2x2-1/2 in.	D256	ft. lb./in. notch	0.30
Tensile Strength	1/8 in. specimen	D651	psi	6,800
Flexural Strength	1/4x1/2x5 in.	D790	psi	8,600
Modulus of Elasticity in Flexure	1/4x1/2x5 in.	D790	psi	11×10^5
Compressive Strength	1/2x1/2x1 in.	D695	psi	29,200
Dielectric Strength, Short Time	1/8x4 in. disk	D149	volts/mil	306
Volume Resistivity	1/8x4 in. disk	D257	ohm-cm.	6.1×10^{12}
Dielectric Constant, 60_3 cycles	1/8x4 in. disk	D150	...	7.23
10^3 cycles	1/8x4 in. disk	D150	...	6.37
10^6 cycles	1/8x4 in. disk	D150	...	5.17
Dissipation Factor, 60_3 cycles	1/8x4 in. disk	D150	...	0.15
10^3 cycles	1/8x4 in. disk	D150	...	0.08
10^6 cycles	1/8x4 in. disk	D150	...	0.04
Deflection Temp. at 264 psi	1/2x1/2x5 in.	D648	deg. F.	335
Water Absorption, gain in weight	1/8x2 in. disk	D570	per cent	0.28

Granulation Plasticity Tabletting Quality Heat Resistance	Grades Available: 6, 9, 12, 15 Can be tabletted with the usual equipment. A 38837 Moldings of this material may discolor, but otherwise experience indicates that exposure to temperatures exceeding 300°F. ordinarily is not recommended but higher temperatures may be withstood if exposures are not prolonged. Trial under expected service conditions is advisable and it is suggested that heat resistance requirements be discussed with a Union Carbide Plastics Company Representative since the effects of elevated temperatures vary for different properties.

The recommendations, test results, property values, and suggestions are offered herein as a guide in the use of these materials and are not a guarantee of their performance. The property values given are those to be expected in the product at the time of manufacture. These values are dependent upon using the testing methods as indicated. Properties more certain to be realized are measured with lesser frequency than others as is usual where manufacturing operations are closely controlled. If applications require continual verification of a certain property or properties, requirements should be discussed with a Union Carbide Plastics Division Technical Representative.

Union Carbide Plastics Division of Union Carbide Corporation reserves the right to alter the formulation and to discontinue the production of this product at any time.

NEW PRODUCT DATA SHEET

'BAKELITE' PHENOLIC MOLDING MATERIAL

BMMA-~~5440/0001~~5138
Black 25 DC

Tentative

DESCRIPTION: BMMA-5440 is a wide latitude, general purpose compound which molds with an exceptionally smooth surface and has better dimensional stability at elevated temperatures and in high humidities than counterparts in the same specific gravity range. This improved product is made for all types of molding. Though it is particularly well suited for decorative appliance parts, it can also be used for electrical and functional parts requiring good dimensional stability.

PROPERTY	SPECIMEN	TESTING METHOD	UNIT	VALUE
Specific Gravity	...	D792	...	1.40
Bulk Factor	...	D392	...	2.1 max.
Pourability	...	D792	seconds	--
Molding Shrinkage	1/8 x 4 in. disk	D955	inch/inch	.004
Izod Impact Strength	1/2x1/2x2-1/2 in.	D256	ft. lb./in. notch	0.29 min.
Tensile Strength	1/8 in. specimen	D651	psi	7,300 av.
Flexural Strength	1/4x1/2x5 in.	D790	psi	9,800 av.
Modulus of Elasticity in Flexure	1/4x1/2x5 in.	D790	psi	1.05×10^6 av.
Compressive Strength	1/2x1/2x1 in.	D695	psi	31,200
Dielectric Strength, Short Time	1/8x4 in. disk	D149	volts/mil	340
Volume Resistivity	1/8x4 in. disk	D257	ohm-cm.	3.2×10^{12}
Dielectric Constant, 60_3 cycles	1/8x4 in. disk	D150	...	7.0
10^3 cycles	1/8x4 in. disk	D150	...	6.0
10^6 cycles	1/8x4 in. disk	D150	...	4.5
Dissipation Factor, 60_3 cycles	1/8x4 in. disk	D150	...	0.13
10^3 cycles	1/8x4 in. disk	D150	...	0.08
10^6 cycles	1/8x4 in. disk	D150	...	0.04
Deflection Temp. at 264 psi	1/2x1/2x5 in.	D648	deg. F.	350
Water Absorption, gain in weight	1/8x2 in. disk	D570	per cent	0.24

Granulation Plasticity Tabletting Quality Heat Resistance	Grades Available: 6, 9, 12 A 10838 Can be tabletted with the usual equipment. Moldings of this material may discolor, but otherwise experience indicates that exposure to temperatures exceeding 300°F. ordinarily is not recommended but higher temperatures may be withstood if exposures are not prolonged. Trial under expected service conditions is advisable and it is suggested that heat resistance requirements be discussed with a Union Carbide Plastics Company Representative since the effects of elevated temperatures vary for different properties.

The recommendations, test results, property values, and suggestions are offered herein as a guide in the use of these materials and are not a guarantee of their performance. The property values given are those to be expected in the product at the time of manufacture. These values are dependent upon using the testing methods as indicated. Properties were certain to be realized are measured with lesser frequency than others as is usual where manufacturing operations are closely controlled. If applications require continual verification of a certain property or properties, requirements should be discussed with a Union Carbide Plastics Division Technical Representative.

UNION CARBIDE CORPORATION
Chemicals and Plastics — Bound Brook, New Jersey

To: Mr. C. F. Martino
Mr. P. B. Potter - NY
Mr. G. R. Stringer (2)

Date: May 29, 1973

cc: Mr. E. Bell
Mr. W. L. Carrick
Mr. F. W. Ducca
Mr. J. L. Goodson
Mr. H. C. Gunst
Mr. E. W. Krummel - NY
Mr. L. Madestau
Mr. R. T. Marold/R. A. Ream
Mr. P. S. O'Neal - NY
Mr. P. A. Thomas

[redacted]

Subject: Molding Material Meeting
May 18, 1973

1. Canada
2080 is actively being produced in Canada. A run of 2035 has been made and we are awaiting feedback from Controls Corp. 0750, 3001 and 5418 will be made in Canada shortly. P. B. Potter will pursue the possibility of producing 2085 in Canada (a plasticity test may need to be developed). A recent run of 2085 sintered badly in tote bins. F. W. Ducca will check the melting point of the 4249 resin used to determine if that is the problem or if we still have a major sintering problem with this product.

2. Appearance Problem - 3066 and 7002
P. B. Potter will investigate the possibility of going to EMG granulation for both Washington and Conart when pricing problems are resolved. F. W. Ducca will change the formula replacing 8370 with 8390.

3. Asbestos
60M pounds of EMMA-6935 will be produced in late May to evaluate the substitution of a 70/30 and a 50/50 ratio of U.C.C. Calidria SG-200 asbestos/$CaCO_3$ in place of the Carey asbestos. G. E. Baler will write a letter summarizing heat resistance, machinability and formula costs for these two formulas versus our current formulation.

4. Automotive Specifications
We are still awaiting Ford approval on new flexural strength specifications for 5310 and 5303.

5. Dustiness
The run of 5440 made with coarser screens matched approximately the granulation of the Durez material and was slightly less dusty then our standard product. Northland Aluminum and Woodland have been sampled and we are awaiting feedback.

6. Capacity/Fines Recirculation
A 13839
L. Fishberg will investigate how EXL is recirculating fines to the finish roll on his trip in early June. Specific problems are dustiness at finish roll, squeeze roll plug-ups, and poor fluxing of the raw mix without fines at the charge roll. Also to be determined is why EXL does not recirculate all fines to the finish roll and if they have future plans in that regard. Manufacturing will determine if a variable pitch screw which compacts the raw mix will allow a faster rate to the charge roll.

[redacted]

7. Spiral Flow
Work is continuing to resolve startup problems with the new press.

8. Asbestos Warning Label
New bags have been ordered with an asbestos warning statement. Delivery is expected in June.

9. EMRS-5314 Grade 18
170M pounds of the obsolete inventory was consumed as rework during the May run. The balance will be consumed in June.

10. Obsolete 29" Square D Boxes
F. A. Schillinger will supply P. B. Potter with specifications on these boxes versus standard gaylords. P. B. Potter will determine if they can be used for other customers to avoid the $2,640 write-off.

11. SAG Committee Actions
a. Westinghouse complained about poor feeding of EMRS-7021 to injection machines. The specific batch had a density of .44. Manufacturing does not believe that the .45 minimum density specification and .48 minimum impact specification are compatable. P. B. Potter will see what can be done to change one or the other.
b. EMRS-5353 - Hamilton Beach would like a coarser granulation. P. B. Potter will determine if other customers will accept a coarser granulation. If so, C. F. Martino will recommend screens to produce a granulation similar to Durez 480 and Genal 4300 and a run will be made.
c. 7009 - Several batches have been shipped with densities below the .63 minimum with no problems. F. W. Ducca will follow the recent .61 batch which was shipped and if approved by the customer, the density specification will be lowered.
d. EMMA-5314 - The recent pourability complaint was confirmed by the 5/8" funnel pourability test. Random batches of current production will be tested by 5/8" funnel procedure to determine if the problem is limited to this one run.
e. P. B. Potter stated his urgent need for updated data sheets. Quality Control will work on these. Since the 5303 data is already available, These sheets can be developed quickly.
f. It has been 3 months since 1/3 of the asbestos was removed from 7950 and replaced with limestone. Mainufacturing recommended removing 1/2 of the remaining asbestos. This will be delayed until overall plans for removing asbestos from products is further developed.

The next meeting will be Thursday, June 21st at 9 a.m. in the Building 4 Conference Room.

A 13840

F. A. Schillinger

FAS:eb

BAKELITE COMPANY
DIVISION OF UNION CARBIDE CORPORATION
30 E. 42nd STREET
NEW YORK 17, N. Y.

MS NO. 1172

A Preprint

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PHENOLIC RESINS AND MOLDING MATERIALS

by

R. K. Louis*

Presented before
Milwaukee Section
The Society of Plastics Engineers
Milwaukee, Wisconsin
May 14, 1957

[redacted]

* Technical Representative

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New York 17, N. Y.

A 13841

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The recommendations, test results, and suggestions are offered herein as a guide in the use of these materials and are not a guarantee to their performance. Each user must establish for himself the most suitable formulations, production methods, and control tests to ensure the uniformity and quality of his product.

Nothing contained herein shall be construed to constitute a permission or recommendation to practice any invention covered by any patent without a license from the patent owner.

Bakelite Company has highly trained engineers in the field ready to serve you, and these technical representatives will be glad to discuss individual problems.

PHENOLIC RESINS AND MOLDING MATERIALS

The term, phenolic resin, includes a broad variety of products being made by reacting a phenol with an aldehyde under various processing conditions. Such a reaction was first described by Baeyer in 1872. However, little attention was paid to the resinous reaction taking place between phenol and formaldehyde until the period 1890-1910. During this time, it seems that the principal effort of the investigators was to produce an artificial shellac. None of the products produced in these investigations was a commercial success as a shellac substitute. Neither were they successful as molding compositions because the resins were too brittle and porous.

Dr. Leo H. Baekeland studied the phenol formaldehyde condensation products from 1905-1909 and soon realized that they could not be handled in the same manner as the conventional resins of that period. He made two proposals to overcome the difficulty previously experienced in molding the phenolic resins. They were (1) the use of a filler to overcome the brittleness, and (2) the use of heat and pressure during molding. The application of pressure overcame the bubbling and porosity which earlier investigators had observed, and the temperature could be raised to the point where short molding time was obtained. Baekeland announced his discoveries in 1909.

Thus, the phenolic resins were the first commercial synthetic heat-hardenable plastics. They have been made and sold for almost fifty years. During this time, annual production has been consistently large and technological applications quite varied.

A10842

The resinoid is the prime ingredient in phenolic plastics. The fillers, such as woodflour, asbestos, fabric or paper, are used to accentuate certain properties. Some of these desired characteristics are better molding qualities, greater strength, and better heat resistance. Because of their dimensional

[redacted]

stability, electrical insulating qualities, chemical resistance, and economy, the phenolics are outstanding among the moldable plastics. Their unique combination of properties is responsible for their widespread use throughout all branches of industry.

The commercial phenols are phenol, cresol, xylenol, p-t-butyl-phenol, p-phenylphenol, bisphenol and resorcinol. The most important aldehydes are formaldehyde and furfural. Commerically, the most commonly used are phenol and formaldehyde, phenol and furfural, and resorcinol and formaldehyde.

PHENOL-FORMALDEHYDE

Two general types of reactions are employed in the manufacture of phenol-formaldehyde resins, involving different ratios of formaldehyde to phenol with acid and alkaline catalysts, respectively. In either case, initial reactions of formaldehyde with phenol yield phenol alcohols. These aromatic alcohols then react with additional phenol and aldehyde to make extended and cross-linked resinous chains. Through control of purity and proportion of each reactant, reaction time, and temperature, resins of many diverse properties may thus be obtained.

If the reactants involve a ratio of at least one part of formaldehyde to one part of phenol, generally with an alkaline catalyst, the final product is referred to as a one-step resin. The initial phenol alcohols formed contain one or more methylol groups. These phenol alcohols are known as resols or A-stage resins, and are fusible and soluble in solvents and alkalies. One product of this intermediate A-stage is known as saligenin, which is available as a purified chemical. Through further reaction of the methylol groups, chaining and then cross-linking occurs. Thus, resols can be cured, on heating, to infusible insoluble products. As condensation proceeds beyond the A-stage, the resins enter the B-stage and are called resitols. Molecular weights of the B-stage resins are

A13843

of such a size that the resins are no longer readily soluble in alkalies, although they are still soluble, or partially soluble, in organic solvents such as acetone or alcohol. Cross linkage has not proceeded very far, and the resins are softened by heat, although hard and brittle when cooled. Resites represent the commercial stage of polymerization, with a large amount of cross linkage. Resites, or C-stage resins, are relatively insoluble and infusible.

If a ratio of less than one part of formaldehyde to one part of phenol is used, generally with an acid catalyst, the resultant resin is a novolak and is permanently fusible. If desirable, novolaks can be converted, with additional formaldehyde, to insoluble, infusible products. Hexamethylenetetramine is usually added to the pulverized novolak for this purpose because, under heat and pressure, it yields methylene and ammonia. With ammonia serving as a catalyst, the methylene completes the reaction, forming a resin referred to as two-step, which is capable of producing practically infusible and insoluble plastics.

Acid catalysis, typical of the conventional two-step resins, produce a phenolic resin of relatively slow cure. However, through the use of selective catalysts , it is possible to control the structure of molecular formations to produce resins of faster cure. By using oxides of zinc, aluminum, or magnesium as a catalyst instead of the usual acid, chaining takes place largely in the ortho positions on the benzene ring, thus leaving open the para positions for cross-linking and giving a commercial phenolic resin capable of rapid cure. Resins based on selective catalysts, but with intermediate rates of cure, are possible to produce by careful control of reaction conditions. These include catalysts, temperature, pH, ratio of reactants and reaction time. The states of resin formation are not clearly defined but pass gradually one into another. After the desired degree and type of condensation has been achieved, dehydration and purification is carried out until the desired viscosity is reached, and the liquid

resin is cooled. For varnishes and similar solutions, a solvent is added after substantially complete dehydration of the hot reaction mixture, and the product is cooled. Blending and filtering precede packing. Lump and powdered forms are produced by running the resin, after concentration and dehydration is completed, onto cooling floors or pans. The cooled resin is either broken into lumps and shipped as such, or ground to powder for further processing.

PHENOL-FURFURAL

Formaldehyde is the aldehyde used in greatest quantity by the phenolic resin industry; furfural is the most prominent of the aldehydes used for modifying purposes. Furfural as currently used by phenolic resin manufacturers contributes special and useful flow properties to the phenolic resins of commerce.

It is primarily used in reaction with synthetic phenol to prepare lump resins which in turn are ground and blended with fast-curing formaldehyde-phenol powdered resin in suitable ratios. Another obvious and practiced method is to react mixtures of furfural and formaldehyde with phenol in the reaction kettle itself. In either case the blends thus produced are either compounded with fillers in the case of molding powders, or become phenolic resins of commerce as binders for resinoid abrasive wheels, brake linings, adhesives, laminating varnishes, and the like.

In many uses of thermosetting phenolic resins, the ratio of the rate of flow under the application of heat, or heat and pressure to the time of cure, is the governing factor in the usefulness of a resin. This relation of the physical property of flow to the time required to convert the product to the infusible stage is recognized as being especially important in molding applications. The optimum balance of flow and rate of cure results in fast cure with the maximum to be had in strength and appearance of the molded piece.

A 10845



In general and assuming the use of synthetic phenol as the phenol body, the lower the molecular weight of the aldehyde the shorter the flow period, due to increased cross-linking rate. In the case of formaldehyde the flow interval is very short; i.e., gelation is reached rapidly and complete cure follows almost immediately. In many phenolic resin uses, this is desirable, but for any important number of uses the flow interval of formaldehyde reaction products is too short. In the case of furfural, the flow interval is long due to a slow rate of reaction. Hence, the phenolic resin industry employs combinations of furfural and formaldehyde in numerous instances, thereby providing a complete spectrum of flow-cure properties. Technically, the phenol-furfural combination acts as a type of "inhibiting agent" that decreases the rate of reaction of the unreacted phenol and formaldehyde. The terms of "furfural-phenol" or "formaldehyde-phenol" are therefore coming less useful in being able to describe accurately the contents of most commercial phenolic resins.

Furfural as supplied commercially is essentially anhydrous and therefore offers an advantage in shipment and storage as well as in the manufacturing operation. Kettle capacity is enhanced since there is less water to be removed during the reaction period than with the use of formalin.

The single largest application of furfural in the phenolic resin industry is in the production of molding compounds. Five years ago the present giant-sized phenolic moldings were unheard of. Since that time phenolic molding powder manufacturers pioneered the development of long-flow compounds, and in cooperation with press builders and molders, made possible the deep-draw molding of a large TV console cabinet and other large and complex moldings.

RESORCINOL-FORMALDEHYDE

Resorcinol has a higher rate of reactivity than phenol under some conditions. The order of reactivity of resorcinol with formaldehyde is such [redacted]

A 13346

that no catalysts are necessary to induce reaction, and reaction will take place under alkaline or acid conditions. By reacting one mol of resorcinol with substantially less than one mol of formaldehyde, novolak resins are obtained which are permanently fusible and soluble in water, ketones, alcohols, esters, and similar organic solvents. These resins can be repeatedly heated with no substantial change in properties. By dissolving in a solvent medium, usually water and alcohol, and adding a catalyst in an amount sufficient to bring the $_{p}H$ of the solution to approximately 7, an adhesive base is formed which can be set in the presence of a hardening agent, generally formalin or paraformaldehyde. In a similar manner, copolymer phenol-resorcinol-formaldehyde adhesives can be prepared which set at a $_{p}H$ of about 8 and show about the same reactivity as shown by resorcinol adhesives.

Variation in properties of resorcinol resins are found to be a function of $_{p}H$ as well as of the formaldehyde-resorcinol ratio. Some resins are capable of reaction at room temperature, and many commercial adhesives are formulated to set at 75 to 90° F. within controlled time periods of several minutes to several hours. Reaction in the presence of heat can be made almost as flash cure rates. Such rapid-hardening blends, however, may give aging difficulties (high rate of color change to light exposure) at room temperatures.

Selected resorcinol adhesive mixtures are characterized by reasonable stability. However, loss of solvents due to opened containers may alter the formulation. Use of fillers, such as walnut shell flour and the like, has been found effective in increasing the strength and stability of glue lines. In proper proportions, these fillers give optimum performance in toughness and in resistance to cracking,

Resorcinol resins can be used quite generally where phenolics are used. The low temperature cure is particularly helpful in the fabrication of heavy

structures with thick sections where slow heat retards the cure of normal phenolics, or in gluing odd-shaped pieces that cannot be handled well between the flat platens of a hot press. Because of their high affinity for wood, the most important use of these resin adhesives has been in wood gluing, particularly for marine plywoods. Less well-known applications are in various bonding operations on laminated and molded phenolics, nylon, and other plastic materials.

Industrial Resins

The term "industrial resins" originates from the large number of industries that find that phenolic resins are a necessary part of their product formulation. The ultimate consumer rarely realizes that these products contain phenolic resin, and the products are not usually regarded by the public as plastics.

The industries consuming large quantities of phenolic industrial resins include those that manufacture exterior grade plywood, laminates, heat and sound insulation, grinding wheels, abrasive paper, foundry molds, rubber goods, wood waste products, insulating varnishes, castings, and a host of other end products in which the use of phenolic resins makes a better article possible.

Industrial phenolic resins are generally tailor-made for a specific field of use and frequently for an individual user. The versatility of the phenolic system of resins is brought out in the industrial applications. No other resin system fits so many diversified fields.

The properties which make phenolic resin so popular in the industrial field include heat, chemical, water, and corrosion resistance, electrical insulating qualities, and bonding properties for a wide variety of materials.

Molding Materials

Granular and macerated molding materials - Both one-step or two-step

resins or their many variations are employed for these materials, the type selected depending on properties desired. The heat-reactive resins are used as such by condensing further and processing with dyes, lubricants, and/or plasticizers until the desired molding properties are achieved, or are compounded with fillers for the purpose of further modification of the properties. The latter include compounds that incorporate either organic or inorganic fillers in ground or in macerated form. Woodflour, cotton flock, asbestos, and similar granulated products; or macerated natural or synthetic fabric, fibers, or films; or paper are fillers frequently employed. Fibrous glass, chopped glass cloth, and the new synthetic fibers have recently been introduced as fillers, presenting interesting new properties. Sometimes the molding compounds are too bulky due to the incorporated filler and are further processed to produce a product that is in a pellet or nodular form. This form facilitates handling and preforming during the molding process.

The various phenolic molding compounds are often designated by the properties they impart to molded products, and are commonly known as general purpose, shock-resistant, heat-resistant, and special purpose phenolics. When fully cured, phenolic molding compounds are relatively inert. With the exception of special grades, they are measuredly decomposed by strong caustic solutions. Molded pieces are hard, rigid, durable, and difficult to ignite or slow burning. Because the usual phenolic materials show a marked tendency to discolor when exposed to light; dark colors are recommended. Indoor aging characteristics are good. In general, curing temperatures range from 275 to 350° Fahrenheit. Unless special grades of materials and special techniques are used, pressure is required for the cure. Compression, transfer, or plunger techniques, which increase the flow and alignment of plastics, can be employed. Large pieces can be successfully molded and show good tolerance for inserts. The range of end products which phenolic molding materials provide is almost unlimited.

Phenolic resin boards and blanks - Phenolic resin-pulp boards are produced on a wet cylinder machine, usually in standard size sheets, 48 by 66 in., and thicknesses ranging from 0.031 to 0.045 inch. From these boards the manufacturer supplies sheets, strips, rectangles, special shapes, and diced material. Products are characterized by low bulk factor and relatively high mechanical strength, dimensional stability, and moisture resistance. Properties can be somewhat tailored by variations in the processing. The material can be handled in molds for general purpose phenolics. It can be used either for producing finished pieces or in conjunction with standard phenolics to provide reinforcement. In many cases the proper use of blanks with other molding materials will produce a piece having a combination of mechanical and dielectric strength, and good color not obtainable in the boards alone. Resin boards and blanks are suitable for the production of many industrial and household items.

Phenolic pulp products - By the use of pulp resin preforms, articles may be made up of layers in which the body or core contains a high percentage of fiber and a low amount of resin, while the surface layers are richer in resin than fiber. When cured, the several layers are firmly bonded by the fluxed and hardened resin into a single piece, whose surfaces have high resistance to wear or fluids which may come into contact with them. The body layer, due to its high fiber content, gives the article its high strength. A recent development, covering the use of decoratings or inserts on the surface of serving trays or other flat pieces, finds the shaped preform particularly advantageous, as it offers a flat surface on which these items may be easily and accurately placed. For complex shaped articles and articles of varying sectional thickness, for which molded-to-shape preforms are not adapted, a special pulp resin blank is used. This blank is also vacuum felted from an aqueous pulp resin mixture to the shape best suited for obtaining uniformity of pulp and resin distribution in the finished product, when compression molded in the conventional manner. The high

A 10950

strength of the finished article results from its fiber structure being unchanged, except for compacting, from its condition in the original preform.

Rubber-phenolic compounds - Within the past few years, use of phenolic resins with synthetic rubbers, such as GR-A, GR-S, and "Neoprene," has made possible improved molding compounds which process readily, cure faster than rubber, and produce finished articles of special properties. The resin in moderate quantities can act as a reinforcing agent for the rubbers, imparting hardness, or the rubber can be utilized as a plasticizer for the resin, giving a product which is softer and tougher than that which is otherwise obtainable with phenolic resins.

The rubber-phenolics have interesting properties which permit them to compete with metals, wood, ceramics, thermoset laminates, and straight phenolic molding materials. They generally mold well in molds that have been constructed for general-purpose phenolic materials. Mold shrink allowance is sometimes a more intangible factor than for other phenolics, but a full scale of shrink allowance has been established for some of the blends.

An inherent characteristic of rubber-phenolics is the relative resiliency of the material on release from the mold. Thus, the design and location of knockout pins have to be carefully considered. In parts requiring great accuracy, shrink fixtures for slow cooling are frequently used. The best molding temperature is reported to be between 340 and 350° Fahrenheit. Cycles may be up to 20% longer than for standard phenolic materials, and minimum pressures should be used commensurate with the proper density of the molded part.

The rubber-phenolic molding compounds are ideally suited for transfer or plunger molding, because they are fundamentally soft and have a long duration of flow.

Molded parts containing rubber do not need as much reinforcement from

the standpoint of ribbing or fluting, or excess radii at corners, or thicker sections, as do standard phenolics.

Phenolic resin-asbestos composition - A phenolic resin-asbestos composition ("Haveg", Haveg Corp.) has been developed which makes possible the economical production of large, complex pieces of equipment through simplified molding techniques. This material is available from the manufacturer only in the form of finished equipment--factory molded to the desired shape. The molding process consists of packing a putty-like composition into a simple mold in which the resin is cured under controlled temperature conditions without using a hydraulic press. Because of the simplicity of the mold construction, this procedure is used to produce small quantity runs or even individual pices without the introduction of prohibitive mold amortization charges into the final price.

The asbestos filler used is acid digested and the baked product is, therefore, resistant to almost all non-oxidizing acids, salts, the weaker bases, and many solvents. Graphite is substituted for the acid-washed asbestos in equipment intended for hydrofluoric acid or acid solutions of its salts. These compositions are characterized by strength, toughness, and resistance to thermal shock, and can withstand sustained temperatures of 300° Fahrenheit. Large molded pieces which are subjected to considerable hydrostatic heads or gas pressures are provided with external support, which usually consist of steel ribs or wood staves with steel hoops. It is possible to make field alterations or repairs with cold setting cements which, when hard, have comparable chemical resistance to the baked phenolic material.

In addition to the basic types discussed, phenolics may be classified according to their intended use in commercial and industrial applications.

General-purpose phenolic materials are distinguished by their all-round

[redacted]

serviceability. This class of products consists generally of cellulose-filled materials and are capable of being molded under a wide variety of conditions, producing parts of clean lustrous finish. Easiest to handle, and frequently the most economical to use, they possess a broad range of molded properties that will meet the requirements of a majority of applications. Typical applications for these materials include wire devices, components for household appliances, brush handles and automobile parts.

General-purpose phenolics with improved water resistance are used for closure materials such as bottle caps and jar covers. Certain general-purpose phenolics are designed to impart prime quality in appearance. Camera cases, radio cabinets, molded drawers, and telephone parts exemplify this particular resin.

General-purpose materials with improved impact strength possess from 1.3 to 2.0 times greater Izod impact strength than other general-purpose resins. For this reason, they are used in instrument casings, meter housings, and washing machine agitators.

Special high impact-resistant phenolic materials offer up to sixteen times the Izod impact strength of the general-purpose phenolics. In addition, some of these materials have improved moisture resistance under longer periods of immersion, exposure to high humidities and at high temperatures of immersion. These paper, fiber, pulp, fabric and cord-filled materials possess impact strengths in the range of 0.60 to 8.0 ft./lb. per inch of notch.

Very often the use of molded parts requires a shock resistance greater than that obtained with general-purpose. For this reason, high impact resistant phenolic came into being. The user of molded parts should bear in mind that the greater the shock resistance of the material, the more difficult it will be [redacted]

A 13853

mold. This is because of the bulk factor encountered in the type of filler employed. Consequently, the purpose of having a range of shock-resistant materials available, is to provide intermediate impact strength which is adequate for a given use without unnecessary sacrifice of molding and performing qualities. Uses of shock-resistant materials range from telephone handsets and tool housings to heavy duty flashlight cases and oil-well drilling equipment.

Heat-resistant phenolic is another important class. While being the most dimensionally stable of all phenolics, this material provides a maximum degree of heat resistance in conjunction with other necessary products.

Heat-resistant phenolics are somewhat more difficult to process in the tabletting and molding operations than the cellulose-filled materials, and parts molded from them are less easily machined. This is caused by the presence of a mineral filler.

These materials are employed when higher heat resistance and better water resistance are desired. Furthermore, they have a lower coefficient of heat expansion and lower shrinkage in the molding operation.

A number of these materials has been developed, each especially suited to a particular type of service. Applications include molded commutators, heater connectors, outdoor insulation, handles of toasters and cooking utensils and other uses where the special property of better heat resistance is required.

Low-loss electrical phenolics are another example of the application of phenolics in specialized uses. This material is recommended for use where low power factor, low loss factor, high resistivity, dimensional stability, and low water absorption are desired. Capacitor casings and frames, condensers, coil forms, automobile and aircraft distributors and resistors typify its use in the electrical field.

A 13854

There are many so-called "special phenolics." These include diverse materials used in applications requiring particular properties or particular combinations of properties. One example would be phenolics with improved chemical resistance. This type would be utilized in vaporizers, milking equipment, automatic washing parts, bottle caps and other applications where resistance to water, acids, alkalies, oils and greases are likely to be encountered.

Low frictional phenolics are used in products requiring a low coefficient of friction, such as heavy-duty bearings and caster wheels. There is even a special phenolic formulated for x-ray tube housings and component parts of x-ray equipment. This material is employed to prevent the escape of radiation.

Examples of Compounds with Asbestos
BMM 5303
BMRS 5303
BMMA 5353

RECEIVED
OCT 10 1972

THIS COPY FOR WDN

P. B. Potter
Chemicals & Plastics
New York

October 5, 1972

Boston Sales Office

L. D. Fishberg
E. W. Krummel
J. J. Madden
C. F. Martino
A. S. Olivo
P. S. O'Neal
P. L. Rodts
M. Skigis
N. E. Stuesey
A. J. Wiltjer

GENERAL ELECTRIC COMPANY
- - - - - - - - - - - -
Elimination of Molding Material Using Asbestos

E.A. LAWRENCE - URGENT! LET'S DISCUSS. PROBLEM OR OPPORTUNITY?
EKrummel

During the past two weeks, the fact that General Electric has planned to discontinue the manufacture of heat-resistant phenolic molding material using asbestos as a filler, became known and later confirmed as true. During a discussion with Mr. Ken Price, Molding Engineer, and Mr. Andy Anderson, Purchasing Agent, at the General Electric plant in Plainville, Connecticut, they indicated the decison had been made five weeks ago because of OSHA requirements. The decision was primarily made for two reasons: first, General Electric didn't want to invest expenditure needed to purchase equipment to meet OSHA requirements in the manufacturing plant; second, one of General Electric's locations which was molding asbestos material was cited for violations of OSHA regulations specifying the minimum asbestos content in the air. ← MAIN PROBLEM

What initially appears to be an excellent chance to gain business where G. E. heat resistant materials are used, may turn into a serious long-term threat to all suppliers of asbestos filled phenolic molding materials. While G. E. sales personnel are discussing their discontinuance of the product with their customers, they are emphasizing the hazards the molders face by using the asbestos filled materials due to OSHA requirements. !!

The initial reactions I have received at three large customers using G. E. asbestos materials have shown deep concern in continuing molding asbestos filled materials. Haskon Inc. has requested letters of policy in the making, handling, and use of asbestos filled phenolics from all of their suppliers as a result of the G. E. visit. Texas Instruments, which uses about 750M lbs. annually of Genal 4300 (asbestos filled), is preparing to begin a full scale evaluation of G. E. heat resistant materials using other fillers instead of asbestos. Mr. Pete Cutler, Production Engineer, indicated that G. E. has assured Texas Instruments that equivalent molding materials without asbestos will be developed to replace Genal 4300 before G. E. discontinues manufacturing the product in January 1973. The G. E. plant in

A 13856

Plainville has indicated that the internal policy for all G. E. plants is to find equivalent substitutes for all asbestos filled phenolic molding materials now being used.

From these initial responses I have received in the New England area, the use of asbestos filled material by molders may seriously become jeopardized. The extent of the problem will be strongly influenced by the success of G. E. to replace the use of asbestos in heat resistant molding materials. As of this date no samples have been sent out by G. E. and indications point to the fact they may not have one developed yet that has been fully tested. But in the meantime, G. E. is creating a demand for a new heat resistant material without asbestos. It appears they are selling a new product before they have one.

With the current situation, I believe UCC should begin taking some positive action. First, it should immediately be determined with the existing OSHA requirements whether the molder risks any possible repercussions in OSHA violations by using asbestos filled molding materials. If not, a detailed letter should be sent to all phenolic salesmen explaining OSHA requirements with the intent for them to explain this information to their customers. If it is shown definite potential OSHA violations exist using asbestos filled molding materials, an active development program should be started to find a suitable replacement for asbestos. — Can't do

Positive action taken now may help reduce possible confusion with our customers in the near future regarding OSHA requirements. If it is found a substitute material is needed, an early development program should help UCC keep a step ahead of competition.

S. B. Nelson

S. B. NELSON

SBN:rrp

[redacted]

A13857

OK Final Dwg 4-13-72

UNION CARBIDE CORPORATION
Chemicals and Plastics

Bound Brook, New Jersey

To: Mr. D. R. Albright
Mr. A. R. Grover
Mr. C. P. Martino
Mr. P. B. Potter - NY-32

cc: Mr. G. E. Ealer
Mr. L. D. Fishberg
Mr. R. E. Graebert
Mr. E. W. Krummel - NY-32
Mr. A. R. Olivo
Mr. F. A. Schillinger
Mr. G. R. Stringer

February 29, 1972

Subject: Final Transfer

BMMA-5440/5441 BK-25 DC
BMRS-5440/5441 BK-25 DC
BMMA-5138 BK-25 DC

Attached are the final manufacturing instructions and quality control tests on the above "B" line products. They all belong to an identical, general purpose, family having the same formulation and quality control tests. Therefore, where practical, they should be scheduled together for manufacturing to obtain maximum production efficiency.

The BMMA-5441 BK-25 DC nomenclature was established to identify this type product when additional testing is required for the government specification, MIL-M-14F, type CFG.

The number BMMA-5138 BK-25 DC is retained since several customers and end users have this number listed on their prints for some heat resistant applications.

This concludes the consolidation program for this group of products with the necessary information for manufacture and control of quality. Additional properties are listed beyond those normally run for quality control in order to provide a better definition of the type for manufacturing and sales purposes.

It should be noted that grade 24 BMRS-5440 BK-25 DC has never been produced with the consolidated formulation.

By copy of this letter, it is requested that George Stringer and Carlo Martino formalize the spiral flow test in writing. The number WC-510A has been assigned to it.

Please approve transfer.

F. W. Ducca

FWD:eb
Attachment

all correction on back
SAE minutes will be
coming through A138[redacted]
4/11/72 GRS

Product Data
(for internal UC use only)

By: F. W. Ducca
February 29, 1972

BMMA-5440/5441 BK-25 DC

I. Description and Use

These products are identical two step BRN-8370 resin, types having wide molding latitude. They have a better molded surface appearance and better dimensional stability than the usual general purpose types. The filler is primarily woodflour with minor amounts of coal and asbestos. They will be supplied in grades 6, 9, and 12 for use in compression and transform molding.

The number BMMA-5441 BK-25 was established to identify the product when additional testing is required to satisfy the military specification MIL-M-14F, government designation CFG. Otherwise, both products are the same in formulation, manufacturing specifications and quality control tests. It is not recognized by Underwriter's Laboratories.

BMMA-5440 BK-25 is listed by Underwriter's Laboratories on a yellow card and is in their recognized component index.

BMMA-5440 BK-25 is not approved for MIL-M-14F.

II. Manufacturing Instructions - See Attachment BA-441-442

III. Quality Control

1. Control Log Tests - Both products

4-13-72 L.F.

Property	Test Method	Limits
Plasticity - Spiral Flow	WC-510A	Standard grades 9 & 12 ✓ 15
- Rossi-Peakes flow	WC-508A	~~Standard grade 6~~ ELIMINATED 4-1-72
Apparent density	WC-2B	0.58 Minimum
Sieve analysis	WC-7-B-4	
+6		0.0
+12		1-12
-60		0-4
Appearance - 4" disc.		Smear - F Max.
		Mottle - 4 Max.
		Hard Particles - 1 Max.
		Indentations - 1 Max.

2. Final Tests - Both Products

4-13-72 L.F.

Property	Test Method	Limits
Plasticity - Spiral Flow	WC-510A	Standard grades 9 & 12 ✓ 15
- Rossi-Peakes flow	WC-508A	~~Standard grade 6~~ ELIMINATED 4-1-72
Specific gravity	WC-1-I	1.38-1.42
Apparent density (1)	WC-2-B	0.58 Minimum
Sieve analysis	WC-7-B-4	
+6		0.0
+12		1-12
-60		0-3

A 10859 [redacted]

(1) This value ~~was~~ 15 obtained by posting average of control densities. If out of limits, density will be run on final.

Product Data
(for internal UC use only)

By: F. W. Ducca
February 29, 1972

BMMA-5440/5441 BK-25 DC (Continued)

2. Final Test - Both Products (continued)

Property	Test Method	Limits
Appearance - 4" disc.		Smear - F Max. Mottle - 4 Max. Hard Particles - 1 Max. Indentations - 1 Max.

In order to satisfy MIL-M-14F type CFG requirements, BMMA-5441 BK-25 has the following additional tests run on every final batch:

Dielectric strength S/S (E-48/50 + D-48/50) WC-77A4	45 volts/mil. - Min.
Flexural strength (E-48/50 + C-96/23/50) WC-91B	9000 psi - Min.
Water absorption (E-24/100 + Des. + D-48/50) WC-78F	3.0% gain - Max.

3. Plasticity Control -

Grade	~~6~~	9	12	15
Test	~~RP Flow~~	Spiral	Spiral	Spiral
Control	~~0.55-0.70~~	11.0-13.0	19.0-21.0	28.0-30.0
Final	~~0.55-0.70~~	9.0-13.0	16.0-20.0	24.0-28.0

4. Special Customer Requirements -

Customer	Requirement	Product
P. R. Mallory	W 512-70 (12-31-70)	BMMA-5441 BK-25 DC
Littelfuse	Ford Spec. ESF-M3D 78A	BMMA-5440 BK-25 DC

IV. Characteristic Properties

These typical properties classify the products for comparison with other UC standard phenolic molding materials and competitive types.

Product	Units	BMMA-5440 BK-25	BMMA-5441 BK-25
1. Resin required	-	BRN-8370+5390	BRN-8370+5340
2. Specific gravity	-	1.40	1.40
3. Impact	ft.lbs./in. Notch	0.30	0.30
4. Dielectric strength S/T	Volts/mil.	340	340
5. Shrinkage	in./in.	0.004	0.004
6. ASTM standard spec. for molding materials - D-700-68 Type		2	2
7. MIL-M-14F Qualified Products List Government designation		Not Listed	(CFG)
8. Underwriter's Laboratories - recognized component listing		on yellow cards E36098B and E36098C. Copy Attached.	Not recognized

A10800C [redacted]

Product Data
(for internal UC use only)

By: F. W. Ducca
February 29, 1972

BMMA-5440/5441 BK-25 DC (Continued)

IV. Characteristic Properties (continued)

Product	Units	BMMA-5440 BK-25	BMMA-5441 BK-25
Flame class 1/16"		Se-0	-
1/8"		Se-0	-
1/4"		Se-0	-
Arc resistance - ASTM D 495		110 sec.	-

V. New Product Data Sheet - See Attachment - Tentative only for manufacturing.

[redacted]

Union Carbide Plastics Division of Union Carbide Corporation reserves the right to alter the formulation and to discontinue the production of this product at any time.

NEW PRODUCT DATA SHEET

Same As 613K

'BAKELITE' PHENOLIC MOLDING MATERIAL

BMMA-5440/5441/~~5500~~
Black 25 DC

Tentative

DESCRIPTION: BMMA-5440 is a wide latitude, general purpose compound which molds with an exceptionally smooth surface and has better dimensional stability at elevated temperatures and in high humidities than counterparts in the same specific gravity range. This improved product is made for all types of molding. Though it is particularly well suited for decorative appliance parts, it can also be used for electrical and functional parts requiring good dimensional stability.

PROPERTY	SPECIMEN	TESTING METHOD	UNIT	VALUE
Specific Gravity	...	D792	...	1.40
Bulk Factor	...	D392	...	2.1 max.
Pourability	...	D792	seconds	--
Molding Shrinkage	1/8 x 4 in. disk	D955	inch/inch	.004
Izod Impact Strength	1/2x1/2x2-1/2 in.	D256	ft. lb./in. notch	0.29 min.
Tensile Strength	1/8 in. specimen	D651	psi	7,300 av.
Flexural Strength	1/4x1/2x5 in.	D790	psi	9,800 av.
Modulus of Elasticity in Flexure	1/4x1/2x5 in.	D790	psi	1.05×10^6 av.
Compressive Strength	1/2x1/2x1 in.	D695	psi	31,200
Dielectric Strength, Short Time	1/8x4 in. disk	D149	volts/mil	340
Volume Resistivity	1/8x4 in. disk	D257	ohm-cm.	3.2×10^{12}
Dielectric Constant, 60_3 cycles	1/8x4 in. disk	D150	...	7.0
10^3 cycles	1/8x4 in. disk	D150	...	6.0
10^6 cycles	1/8x4 in. disk	D150	...	4.5
Dissipation Factor, 60_3 cycles	1/8x4 in. disk	D150	...	0.13
10^3 cycles	1/8x4 in. disk	D150	...	0.08
10^6 cycles	1/8x4 in. disk	D150	...	0.04
Deflection Temp. at 264 psi	1/2x1/2x6 in.	D648	deg. F.	350
Water Absorption, gain in weight	1/8x2 in. disk	D570	per cent	0.24

Granulation	[redacted]
Plasticity	Grades Available: 6, 9, 12
Tabletting Quality	Can be tabletted with the usual equipment.
Heat Resistance	Moldings of this material may discolor, but otherwise experience indicates that exposure to temperatures exceeding 300°F. ordinarily is not recommended but higher temperatures may be withstood if exposures are not prolonged. Trial under expected service conditions is advisable and it is suggested that heat resistance requirements be discussed with a Union Carbide Plastics Company Representative since the effects of elevated temperatures vary for different properties.

The recommendations, test results, property values, and suggestions are offered herein as a guide in the use of these materials and are not a guarantee of their performance. The property values given are those to be expected in the product at the time of manufacture. These values are dependent upon using the testing methods as indicated. Properties here certain to be realized are measured with lesser frequency than others as is usual where manufacturing operations are closely controlled. If applications require continual verification of a certain property or properties, requirements should be discussed with a Union Carbide Plastics Division Technical Representative.

A13862

Union Carbide Corp., Chemicals & Plastics Div.

Phenolic molding compound.

Grade	Min. Thickness (in.)	Temp. Index All Properties	Hot Wire Ign.	Flame Class	High Amp Arc Ign.	High Volt Track Rate	Dielec Arc Resist-ance
BMMA[illegible] (4)	1/16	150	64	SE0	105	8.7	—
		150	143	SE0	121	4.0	110.8
BMMB[illegible] * (4)	1/16	150	240+	SE0	92	2.0	—
		150	106	SE0	75	0	—
		150	218	SE0	40	0	188.0
BMMB[illegible] * (4)	1/16	150	200+	SE0	76	0	—
		150	74	SE0	66	0	—
		150	278	SE0	54	0	183.0

[illegible] December 2, 1970 (4).

[illegible] E36098B dated April 30, 1971.
(Continued on C card.)
[illegible] This card is issued by Underwriters' Laboratories, Inc. ®

Union Carbide Corp., Chemicals & Plastics Div.

BMMB[illegible]	(4)	1/16	150	72	SE0	100	8.7	—
			150	143	SE0	81	4.0	110.8
BMMC-[illegible]	(4)	1/16	150	64	SE1	40	.125	—
			150	147	SE0	116	.125	181
			150	239	SE0	169	.125	—
BM[illegible]		1/16	150	300+	SE1	23	.25	—
BM[illegible]	(4)		150	300+	SE0	23	.25	181
			150	300+	SE0	40	.25	—
BM[illegible]		1/16	150	254	SH	24	.25	—
BM[illegible]	(4)		150	178	SB	85	.25	196
			150	97	SN0	51	.25	—

[illegible] December 2, 1970 (4).

(Continued on D card.)
[illegible] This card is issued by Underwriters' Laboratories, Inc. ®

[redacted]

A13863

PA 441-442

PHENOLIC MOLDING MATERIAL DEPARTMENT - PRODUCT FORMULATION & CONDENSED MANUFACTURING INSTRUCTION

PRODUCT NO.	BMMA-5440/5441 BK-25 DC
ISSUE NO.	8
DATE	2-28-72
SUPERSEDES	1-17-72

CREW SIZE- MEN | COSTING UNIT
EQUIPMENT HOURS-
CLEAN & SET-UP MAN HOURS-
PROCESSING [illegible]-
[illegible] EQUIPMENT HOURS-
PACKING HOURS, M POUNDS-

NOTEBOOK | PAGE
DATE | PROJECT NO.
COST ESTIMATE: REQUESTED | NOT REQUESTED
CUSTOMER AND YEAR [illegible]

HAMMER MILL	
YES	X
NO	

HAMMER MILL SCREEN	
R-1	

[illegible] SCREEN			
UNIT	[illegible]	[illegible]	[illegible]
C-W	5/8	5/8	5/8
C-E	1/2	1/2	1/2

CHARGE ROLLS				
UNIT	SHEET WT.	CYCLE TIME	STARTING TEMP. FRONT	STARTING TEMP. BACK
A				
B				
C	72	35	150	60
R-1				

ROTEX	
A	/
B	/
C West	10/0XX
C East	10/0XX
R-1	/

FINISH ROLLS			
UNIT	CYCLE TIME	STARTING TEMP. FRONT	STARTING TEMP. BACK
A			
B			
C	35	240	200
R-1			

BLEND FOR 20 MINS.

CENT. BLEND. STA.
NOVO: YES [X] NO [ ]

Gump Screen-6 Mesh

SQUEEZE ROLLS			
UNIT	STARTING TEMP. FRONT	STARTING TEMP. BACK	SHEET. THK.
A			
B			
C	Water	250	0.120"
R-1			

SPECIAL COMMENTS:

DIFFERS FROM PREVIOUS ISSUE:

1. Formulation instructions updated.
2. Sp. gr. on controls eliminated.
3. Appearance limits revised.
4. 60 mesh screen limits revised.
5. 6 mesh screen inserted in controls and gump sifter.

General Purpose - Two Step

SALES CLASS

QUALITY CONTROL TESTS

POWDER DENSITY 0.60 Min.

GRANULATION
+ 6 MESH 0.0 %
- + 12 MESH 1-12 ~~1-10~~ %
- + MESH %
- 60 MESH 4 Max. %

IZOD IMPACT

SPEC. GRAVITY

OTHERS
Appearance
Smear - F Max.
Mottle- 4 Max.
Hard Particles - 1 Max.
Indentations - 1 Max.

INITIATED BY:
PREPARED BY:
APPV'D-Q.C.: F. W. Ducca
APPV'D-MFG.:
APPV'D-TECH. SERVICE:

A10864

BA 441-442 (Back)

PRODUCT NO.	BMMA-5440/5441	DATE	2-28-72
ISSUE NO.	8	SUPERSEDES	1-17-72

MATERIAL CODE NUMBER	MATERIAL DESCRIPTION	UNIT AND GRADE (ALL WEIGHTS MUST BE DESIGNATED IN POUNDS PER MIX) UNIT C										% FOR COSTING GRADE
		GR.	GR. 6	GR.	GR.	GR. 9	GR.	GR.	GR. 12	GR.	GR.	———
8370781	BRN-8370 (CAP)	1320	1360	1400	1440	1480	1520	1560	1600	1640		
52046	RM-52-D	200	200	200	200	200	200	200	200	200		
0319781	ZZN-0319	220	227	234	241	248	255	262	269	276		
16076	RM-16-G	1136	1089	1042	995	948	901	854	807	760		
134126	RM-134-L	240	240	240	240	240	240	240	240	240		
18176	RM-18-Q	360	360	360	360	360	360	360	360	360		
25016	RM-25-A	60	60	60	60	60	60	60	60	60		
149046	RM-149-D	364	364	364	364	364	364	364	364	364		
104016	RM-104	100	100	100	100	100	100	100	100	100		
0993631	TYPE "A"	200	200	200	200	200	200	200	200	200		
TOTAL		4200	4200	4200	4200	4200	4200	4200	4200	4200		
	Rework	200	200	200	200	200	200	200	200	200		

TOTAL	
YIELD	

MANUFACTURING INSTRUCTIONS:

1. Use 200 lbs. minimum - 300 lbs. maximum of recycle Type A in each mix.
2. In first two mixes of run, use 3000 lbs. of recycle Type A or rework listed below.
3. Rework shall consist of 5000, 5020, 5138, 5333, 5440, 5441, 5498, 7000, 7002, 7009, 7950.
4. Use all recirculating fines. Distribute evenly in all mixes.

Product Data
(for internal UC use only)

By: F. W. Ducca
February 29, 1972

BMRS-5440/5441 BK-25 DC

I. Description and Use

These products are identical two step, BRN-8370 resin, general purpose types having a wide molding latitude. They have a better surface appearance and better dimensional stability than the usual general purpose types. The filler is primarily woodflour with minor amounts of coal and asbestos.

BMRS-5440 BK-25 DC is recognized by Underwriter's Laboratories and has yellow card listing. It does not have MIL-M-14F approval. It will be made in grades 15, 18, 21, and 24.

BMRS-5441 BK-25 DC nomenclature was established to identify the product when additional testing is required to satisfy the MIL-M-14F, government designation CFG, specification. It is not recognized by Underwriter's Laboratories. It will be supplied in grades 15 and 18 only.

II. Manufacturing Instructions - See Attachment BA-441-442.

III. Quality Control

1. Control Log

Property	Test Method	Limits
Plasticity	WC-510A	BMRS-5440 BK-25 DC Standard grades 15, 18, 21, and 24 BMRS-5441 BK-25 DC Standard grades 15 and 18 only
Apparent density	WC-2B	0.58gm/cc Min.
Sieve analysis	WC-7-B-4	
+6		0.0
+12		1-12
-60		0-4
Appearance - 4" disc.		Smear - RP Max. Mottle - 4 Max. Hard Particles - 1 Max. Indentations - 1 Max.

2. Final Test

Property	Test Method	Limits
Plasticity - Spiral flow	WC-510A	BMRS-5440 BK-25 DC Standard grades 15, 18, 21, and 24 BMRS-5441 BK-25 DC Standard grades 15 and 18 only
Specific gravity	WC-1-I	1.38-1.42
Apparent density (1)	WC-2-B	0.58gm/cc Min.

A 13866

(1) This value was obtained by posting average of control densities. If out of limits, density will be run on final.

Product Data
(for internal UC use only)

By: F. W. Ducca
February 29, 1972

BMRS-5440/5441 BK-25 DC (Continued)

2. Final Test (continued)

Property	Test Method	Limits
Sieve analysis	WC-7-B-4	
+6		0.0
+12		1-12
-60		0-3
Appearance - 4" disc.		Smear - RP Max. Mottle - 4 Max. Hard Particles - 1 Max. Indentations - 1 Max.

3. Plasticity Control -

Grade	15	18	21	24
Control	28.0-30.0	38.0-40.0	46.0-48.0	54.0-56.0
Final	24.0-28.0	32.0-36.0	40.0-44.0	48.0-52.0

4. Special Customer Requirements

Customer	Requirement	Product
Littelfuse	Ford Specification ESF-M3D-78A	BMRS-5440 BK-25

IV. Characteristic Properties

These typical properties classify the products for comparison with other UC standard phenolic molding materials and competitive types.

	Product	Units	BMRS-5440 BK-25 DC	BMRS-5441 BK-25 D
1.	Resin required	-	BRN-8370	BRN-8370
2.	Specific gravity	-	1.40	1.40
3.	Impact	ft.lbs./in. Notch	0.30	0.30
4.	Dielectric strength S/T	Volts/ mil.	340	340
5.	Shrinkage - compression	in./in.	0.004	0.004
	- injection	in./in.	0.007	0.007
6.	ASTM, standard spec. for molding materials - D-700-68 Type		2	2
7.	MIL-M-14F Qualified Products List-Government designation		Not Listed	CFG
8.	Underwriter's Laboratories - recognized component listing		on yellow cards E36098B and E36098C. Copy Attached.	Not recognized

[redacted]

A10867

Product Data
(for internal UC use only)

By: F. W. Ducca
February 29, 1972

BMRS-5440/5441 BK-25 DC (Continued)

IV. Characteristic Properties (continued)

Product	BMRS-5440 BK-25 DC	BMRS-5441 BK-25
Flame class 1/16"	Se-0	-
1/8"	Se-0	-
1/4"	Se-0	-
Arc resistance - ASTM D 495	110 sec.	-

V. New Product Data Sheet - See Attached

A13868

HA 441-442

PHENOLIC MOLDING MATERIAL DEPARTMENT - PRODUCT FORMULATION & CONDENSED MANUFACTURING INSTRUCTIONS

PRODUCT NO.	BMRS-5440/5441 BK-25 DC
ISSUE NO.	10
DATE	2-28-72
SUPERSEDES	1-17-72

CREW SIZE- MEN | COSTING UNIT
EQUIPMENT HOURS-
CLEAN & SET-UP MAN HOURS-
PROCESSING SIMILAR TO-
LBS/EQUIPMENT HOUR-
PACKING HOURS/M POUNDS-

NOTEBOOK | PAGE
DATE | PROJECT NO.
COST ESTIMATE: REQUESTED | NOT REQUESTED
CUSTOMER AND YEARLY SALES:

HAMMER MILL	
YES	X
NO	

HAMMER MILL SCREENS	
R-1	

GUITER SCREENS			
UNIT	BOTTOM	BOTTOM	TOP
A			
C West	5/8	5/8	5/8
C East	1/2	1/2	1/2

CHARGE ROLLS				
UNIT	SHEET WT.	CYCLE TIME	STARTING TEMP. FRONT	STARTING TEMP. BACK
A				
B				
C	72	35	150	60
R-1				

ROTEX	
A	/
B	/
C West	10/0XX
C East	10/0XX
R-1	/

FINISH ROLLS			
UNIT	CYCLE TIME	STARTING TEMP. FRONT	STARTING TEMP. BACK
A			
B			
C	35	240	200
R-1			

BLEND FOR 20 MINS.

CENT. BLEND. STA.
NOVO: YES ☒ NO ☐

Gump Screen-~~6~~ 3/4 Mesh

SQUEEZE ROLLS			
UNIT	STARTING TEMP. FRONT	STARTING TEMP. BACK	SHEET. THK.
A			
B			
C	Water	250	0.120"
R-1			

SPECIAL COMMENTS:

DIFFERS FROM PREVIOUS ISSUE:
1. Formulation for grade 24 added.
2. Sp. Gr. on controls eliminated.
3. Appearance standards added.
4. 6 mesh screen inserted in controls and gump sifter.

SALES CLASS 6211 0.58 MIN 4/24/72

QUALITY CONTROL TESTS

POWDER DENSITY ~~0.60 Min.~~

GRANULATION
+ 6 MESH 0.0%
- + 12 MESH ~~1-21-10~~ %
- + MESH %
- 60 MESH 0-4 Max.%

IZOD IMPACT
SPEC. GRAVITY

OTHERS
Appearance-4" disc
Smear - RP Max.
Mottle - 4 Max.
Hard Particles - 1 Max.
Indentations - 1 Max.

INITIATED BY:
PREPARED BY: F. W. Ducca
APPV'D-Q.C.:
APPV'D-MFG.:
APPV'D-TECH. SERVICE:

A 10869

PRODUCT NO.	BMRS-5440/5441 BK-25	EC DATE	2-28-72
ISSUE NO.	10	SUPERSEDES	1-17-72

MATERIAL CODE NUMBER	MATERIAL DESCRIPTION	UNIT AND GRADE (ALL WEIGHTS MUST BE DESIGNATED IN POUNDS PER MIX) UNIT C										% FOR COSTING GRADE
		GR.	GR. 15	GR.	GR.	GR. 18	GR.	GR.	GR.	GR.	GR.	
8370781	BRN-8370(CAP)	1680	1720	1760	1800	1840	1880					
52046	RM-52-D	200	200	200	200	200	200					
0319781	ZZN-0319	283	290	297	304	311	318					
16076	RM-16-G	713	666	619	572	525	478					
134126	RM-134-L	240	240	240	240	240	240					
18176	RM-18-Q	360	360	360	360	360	360					
25016	RM-25-A	60	60	60	60	60	60					
149046	RM-149-D	364	364	364	364	364	364					
104016	RM-104	100	100	100	100	100	100					
0993631	TYPE "A"	200	200	200	200	200	200					
TOTAL		4200	4200	4200	4200	4200	4200					
	Rework	200	200	200	200	200	200					
EXTERNALLY												
RM-38726	ZXN-0819	0.15%	0.15%	0.15%	0.15%	0.15%	0.15%					
				(1-1/2 lbs./1000 lbs. of finished material)								

MANUFACTURING INSTRUCTIONS:

TOTAL	
YIELD	

1. Recycle Type A. Unit C, use 200 lbs. minimum - 300 lbs. maximum in each mix.
2. In first two mixes, use 3000 lbs. of recycle type A, or rework listed below.
3. Rework shall consist of 5000, 5020, 5138, 5333, 5440, 5441, 5498, 7000, 7002, 7009, 7950.
4. Use all recirculating fines. Distribute evenly in all mixes.



Continued on next page.

BA 441-442 (Back)

PRODUCT NO.	BMRS-5440/5441 RK-25 DC	DATE	2-28-72
ISSUE NO.	10	SUPERSEDES	1-17-72

MATERIAL CODE NUMBER	MATERIAL DESCRIPTION	UNIT AND GRADE (ALL WEIGHTS MUST BE DESIGNATED IN POUNDS PER MIX)										% FOR COSTING GRADE
		UNIT C										
		GR.	GR. 21	GR.	GR.	GR. 24	GR.	GR.	GR.	GR.	GR.	
8370781	BRN-8370	1920	1960	2000	2040	2080	2120					
52046	RM-52-D	200	200	200	200	200	200					
0319781	ZZN-0319	325	332	339	346	353	360					
16076	RM-16-G	431	384	337	290	243	196					
134126	RM-134-L	240	240	240	240	240	240					
18176	RM-18-Q	360	360	360	360	360	360					
25016	RM-25-A	60	60	60	60	60	60					
149046	RM-149-D	364	364	364	364	364	364					
104016	RM-104	100	100	100	100	100	100					
0993631	TYPA "A"	200	200	200	200	200	200					
TOTAL		4200	4200	4200	4200	4200	4200					
	Rework	200	200	200	200	200	200					
EXTERNALLY ADD 3PBT												
~~TOP~~ 38726	~~ZXN-0819~~	0.15%	0.15%	0.15%	0.15%	0.15%	0.15%					
		(1-1/2 lbs./1000 lbs. of finished material)										
											TOTAL	
											YIELD	

MANUFACTURING INSTRUCTIONS:

1. Recycle Type A. Unit C, use 200 lbs. minimum - 300 lbs. maximum in each mix.
2. In first two mixes, use 3000 lbs. of recycle type A, or rework listed below.
3. Rework shall consist of 5000, 5020, 5138, 5333, 5440, 5441, 5498, 7000, 7002, 7009, 7950.
4. Use all recirculating fines. Distribute evenly in all mixes.



A-CC-71

Guide OBHR2 September 22, 1971 E36098B.
Component—Plastic Materials. (Continued from A card.)

Union Carbide Corp., Chemicals & Plastics Div.

Phenolic molding compound.

Grade	Min. Thickness (In.)	Temp. Index All Properties	Hot Wire Ign.	Flame Class	High Amp Arc Ign.	High Volt Track Rate	D-495 Arc Resistance
BMMA4440 (4)	1/16	150	64	SE0	103	5.7	—
	⅛	150	153	SE0	121	4.0	110.8
	¼	150	300+	SE0	82	2.0	—
BMMD5502 * (4)	1/16	150	106	SE0	75	0	—
	⅛	150	213	SE0	40	0	183.0
	¼	150	300+	SE0	76	0	—
BMRS5303 * (4)	1/16	150	74	SE0	66	0	—
	⅛	150	273	SE0	65	0	188.0

Revised: December 2, 1970(4).

This card replaces E36098B dated April 30, 1971.

(Continued on C card.)

This card is issued by Underwriters' Laboratories, Inc. ©

Guide OBHR2 January 19, 1972 E36098C.
Component—Plastic Materials. (Continued from B card.)

Union Carbide Corp., Chemicals & Plastics Div.

BMRS5440	(4)	1/16	150	72	SE0	106	5.7	—
		⅛	150	153	SE0	81	4.0	110.8
BMMC-2035BK25	(4)	1/16	150	66	SE1	40	.125	—
		⅛	150	147	SE0	125	.125	181
		¼	150	289	SE0	109	.125	—
BMG-6750		1/16	150	300+	SE1	83	.25	—
Nat.	(4)	⅛	150	300+	SE0	83	.25	181
		¼	150	300+	SE0	46	.25	—
BMG-2050		1/16	150	254	SE	24	.38	—
BK-25	(4)	⅛	150	175	SE	83	.38	196
		¼	150	87	SE0	61	.38	—

Revised: December 2, 1970(4).

(Continued on D card.)

This card is issued by Underwriters' Laboratories, Inc. ©

A10872

BMRS-5440/5441
Black-25 DC
General Purpose (Tentative)

DESCRIPTION

- for manufacturing use only

BMRS-5440/5441 BK-25 DC are new injection molding grades offering the best overall combination of properties for general uses. Combines rapid cure with good molding latitude, long barrel life, and high hot rigidity. Has excellent molded appearance. Possesses superior heat resistance and dimensional stability coupled with relatively low specific gravity. First choice for electrical switch parts, appliance parts, and handles.

PROPERTIES

All Tests on Specimens injection molded from unconditioned material.

	TYPICAL VALUES		
FABRICATION			
Plasticity Grades Available	15, 18, 21		
Bulk Factor (D 392)	2.1, max.		
Molding Shrinkage (D 955), inch/inch			
perpendicular to gate	0.0055		
parallel to gate	0.0070		
MECHANICAL			
Izod Impact Strength (D 256), ft.lb./in. notch	0.29		
Compressive Strength (D 695), psi.	32,700		
Tensile Strength (D 651), psi.	7,350		
Flexural Strength (D 790), psi.	14,100		
Modulus of Elasticity in Flexure	1.07×10^6		
ELECTRICAL			
Dielectric Strength, Short Time (D 149), volts/mil	238		
Volume Resistivity (D 257), ohm-cm	0.9×10^{16}		
	60~	10^3~	10^6~
Dielectric Constant (D 150)	18.8	10.1	5.8
Dissipation Factor (D 150)	0.81	0.33	0.06
MISCELLANEOUS			
Molded Specific Gravity (D 792)	1.38-1.42		
Deflection Temp. at 264 psi. (D 648), °F.	375		
Water Absorption, gain in weight (D 570), per cent	0.28		

BMRS-5441 BK-25 DC will be supplied in grades 15 & 18 only

IMPORTANT – This information is offered for your consideration, investigation, and verification. It is not a warranty or representation. It is not permission, or a suggestion to practice a patented invention without a license.
BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation, U.S.A.
UNION CARBIDE CORPORATION • Chemicals and Plastics • 270 Park Avenue, New York, N.Y. 10017

[redacted]

A 13873

Product Data
(for internal UC use only)

By: F. W. Ducca
February 29, 1972

BMMA- 5138 BK-25 DC

I. Description and Use

BMMA-5138 BK-25 DC is a two step general purpose BRN-8370 resin type having good molding latitude, better heat resistance, and better dimensional stability than the usual general purpose material. Filler is woodflour with small quantities of coal and asbestos. It will be supplied in grades 9 and 12 for compression and transfer molding.

The formulation, manufacturing instructions, and quality control of this product are identical with that of BMMA-5440/5441 BK-25 DC. A different number must be retained since several customers and end users have the number BMMA-5138 BK-25 DC specified on their prints. Therefore, it cannot be consolidated by nomenclature until Marketing and Sales have convinced our customers to change to BMMA-5440 BK-25 nomenclature.

II. Manufacturing Instructions - See Attachment BA-441-442

III. Quality Control

1. Control Log

Property	Test Method	Limits
Plasticity - spiral flow	WC-510A	Standard grades 9 & 12
Apparent density	WC-2B	0.58gm/cc Min.
Sieve analysis	WC-7-B-4	
+6		0.0
+12		1-12
-60		0-4
Appearance - 4" disc.		Smear - F Max.
		Mottle - 4 Max.
		Hard Particles - 1 Max.
		Indentations - 1 Max.

2. Final Tests

Property	Test Method	Limits
Plasticity - spiral flow	WC-510A	Standard grades 9 & 12
Specific gravity	WC-1-I	1.38-1.42
Apparent density (1)	WC-2-B	0.58gm/cc Min.
Sieve analysis	WC-7-B-4	
+6		0.0
+12		1-12
-60		0-3
Appearance - 4" disc.		Smear - F Max.
		Mottle - 4 Max.
		Hard Particles - 1 Max.
		Indentations - 1 Max.

A13874

[redacted]

(1) This valve was obtained by posting average of control densities. If out of limits, density will be run on final.

(for internal UC use only)

By: F. W. Ducca
February 29, 1972

EMMA-5138 BK-25 DC (Continued)

3. Plasticity Control - Spiral Flow

Grade	9	12
Control	11.0-13.0	19.0-21.0
Final	9.0-13.0	16.0-20.0

4. Special Customer Requirements - None

IV. Characteristic Properties

These properties classify the product for comparison with other UC standard phenolic molding materials and competitive types.

1. Resin required - BRN-8370
2. Specific gravity - 1.40
3. Impact - 0.30
4. Dielectric strength - 340
5. Shrinkage Comp. - 0.004
6. ASTM, Standard Specification For Molding Materials - D 700-68 Type 2.
7. MIL-M-14-F Qualified Products List (QPL) - Government Designation - not listed.
8. Underwriter's Laboratories - Recognized Component Listing - not recognized.

V. New Product Data Sheet - See Attached

[redacted]

410875

PA 441-447

PHENOLIC MOLDING MATERIAL DEPARTMENT - PRODUCT FORMULATION & CONDENSED MANUFACTURING INSTRUCTIONS

PRODUCT NO.	BMMA-5138 BK-25 DC
ISSUE NO.	9
DATE	2-28-72
SUPERSEDES	1-18-72

CREW SIZE- MEN | COSTING UNIT
EQUIPMENT HOURS-
CLEAN & SET-UP MAN HOURS-
PROCESSING SIMILAR TO-
LOS EQUIPMENT HOUR-
PACKING HOURS/M POUNDS-

NOTEBOOK | PAGE
DATE | PROJECT NO.
COST ESTIMATE: REQUESTED | NOT REQUESTED
CUSTOMER AND YEARLY SALES:

HAMMER MILL	
YES	X
NO	

HAMMER MILL SCREENS	
R-1	

CUTTER SCREENS			
UNIT	BOTTOM	BOTTOM	TOP
C-W	5/8	5/8	5/8
C-E	1/2	1/2	1/2

CHARGE ROLLS				
UNIT	SHEET WT.	CYCLE TIME	STARTING TEMP. FRONT	STARTING TEMP. BACK
A				
B				
C	72	35	150	60
R-1				

ROTEX	
A	/
B	/
C West	10/0XX
C East	10/0XX
R-1	/

FINISH ROLLS			
UNIT	CYCLE TIME	STARTING TEMP. FRONT	STARTING TEMP. BACK
A			
B			
C	35	240	200
R-1			

BLEND FOR 20 MINS.

CENT. BLEND. STA.
NOVO: YES ☒ NO ☐

Gump Screen-6 Mesh

SQUEEZE ROLLS			
UNIT	STARTING TEMP. FRONT	STARTING TEMP. BACK	SHEET. THK.
A			
B			
C	Water	250	0.120"
R-1			

SPECIAL COMMENTS:

DIFFERS FROM PREVIOUS ISSUE:

1. Formulation instructions updated.
2. Sp. gr. on controls eliminated.
3. Appearance limits revised.
4. 6 mesh screen inserted in controls and gump sifter.

Product Description and Use
Two Step, for compression molding.

General Purpose

SALES CLASS

QUALITY CONTROL TESTS

POWDER DENSITY 0.60 Min.

GRANULATION

+ 6	MESH	0.0 %
- + 12	MESH	1-12 ~~1-10~~ %
- +	MESH	%
- 60	MESH	0-4 %

IZOD IMPACT

SPEC. GRAVITY

OTHERS

Appearance
Smear - F Max.
Mottle - 4 Max.
Hard Particles - 1 Max.
Indentations - 1 Max.

INITIATED BY:
PREPARED BY:
APPV'D-Q.C.: F. W. Ducca
APPV'D-MFG.:
APPV'D-TECH. SERVICE:

A10876

SA 441-442 (Back)

PRODUCT NO.	BMMA-5138 BK-25 DC	DATE	2-28-72
ISSUE NO.	9	SUPERSEDES	1-18-72

MATERIAL CODE NUMBER	MATERIAL DESCRIPTION	UNIT AND GRADE (ALL WEIGHTS MUST BE DESIGNATED IN POUNDS PER MIX) UNIT C										% PCR COSTING GRADE
		GR.	GR. 9	GR.	GR.	GR. 12	GR.	GR.	GR.	GR.	GR.	
8370781	BRN-8370 (CAP)	1440	1480	1520	1560	1600	1640					
52046	RM-52-D	200	200	200	200	200	200					
0319781	ZZN-0319	241	248	255	262	269	276					
16076	RM-16-G	995	948	901	854	807	760					
134126	RM-134-L	240	240	240	240	240	240					
18176	RM-18-Q	360	360	360	360	360	360					
25016	RM-25-A	60	60	60	60	60	60					
149046	RM-149-D	364	364	364	364	364	364					
104016	RM-104	100	100	100	100	100	100					
0993631	TYPE "A"	200	200	200	200	200	200					
TOTAL		4200	4200	4200	4200	4200	4200					
	Rework	200	200	200	200	200	200					
RECIRCULATING FINES &	REWORK	3000	3000	3000	3000	3000	3000					
											TOTAL	
											YIELD	

A-1377

MANUFACTURING INSTRUCTIONS:

1. Use 200 lbs. minimum - 300 lbs. maximum of recycle Type A in each mix.
2. In first two mixes of run, use 3000 lbs. of recycle Type A or rework listed below.
3. Rework shall consist of 5000, 5020, 5138, 5333, 5440, 5441 5498, 7000, 7002, 7009, 7950.
4. Use all recirculating fines. Distribute evenly in all mixes.

[redacted]

American Plastics Corporation

Ameroid

Ameroid is a casein sold in sheets, rods, disks and other semifinished forms which are fabricated into buttons and other articles. Casein can be sawed, drilled, tapped, sanded, ground, polished, slotted, threaded, turned and in general worked much like horn, bone, brass, rubber and similar materials. It may be sawed with a jigsaw, bandsaw, hacksaw, circular saw or silicon carbide abrasive disk. The disk when flushed with water gives satisfactory results.

Drilling may be done with carbon or high-speed twist drills. The drills should have ample clearance and on deep holes should be withdrawn several times in the course of drilling to avoid overheating and splitting.

Ameroid rods may be readily turned on hand or automatic screw machines. For turning and milling, the material should be treated about the same as brass.

Punching or blanking may be done by softening the material in hot water or hot oil. The time required for softening depends upon the thickness of the stock. In the case of sheet stock, it is about 24 hr./mm. thickness in room-temperature water. Punching is done with a sharp-edged die similar to leather punches. The die should be about 10% oversize because the material expands.

Grinding is done with abrasive wheels.

Hand polishing of small quantities is usually done by buffing first with wet pumice and then polishing on a clean dry buff with polishing wax. In quantity production, polishing is done in tumbling barrels or with preparations especially prepared for casein plastics. A final polishing is done chemically with a hypochloride solution that imparts a glaze to the finished articles which, when dried by warm air, have a high luster.

Casein plastics may be dyed with aniline dyes.

Athol Manufacturing Company

For more than thirty years this company has been a leading manufacturer of cellulose nitrate and cellulose acetate treated fabrics. Terek cloth and Terekan are the company's trade names for the bookbinding fabrics they have manufactured. They have recently added to their list Terson, a fabric which is vinyl resin coated or impregnated or both. Textile base may be of cotton, rayon, nylon, or other fibers. The treated fabric is flexible at very high and very low temperatures, is both water and fire resistant and very tough. Terson is an elastomer, returning to its original shape after stretching, somewhat more slowly than rubber. It stands repeated flexing very well. Some formulations of Terson showed no breakdown after more than two million folds. The Terson finish may be made smoother than the finish of Pyroxylin and it may be embossed and colored in any number of shades and patterns. It has already found use as upholstery, hospital sheetings, winter jackets, life raft sails, kapok life jackets, airplane engine covers, bedding bags, ski tents, food bags, life raft carrying cases, parachute kits, linings for windproof jackets.

Bakelite Corporation
Unit of Union Carbide and Carbon Corporation
Bakelite Brand Plastics

Available Forms. Bakelite Corporation produces and markets basic, or primary, materials which in most instances are converted into finished products by other manufacturers or fabricators. These materials are supplied in several forms suitable for processing by various methods, such as molding, laminating, casting, and bonding. They are produced under the trade-marks, Bakelite and Vinylite. To avoid confusion among the many products available, those sold under the Bakelite mark will be considered first. Following this, Vinylite plastic products, many of which enter the same fields, will be discussed.

There are Bakelite molding materials in powder, sheet, and granule form; laminating varnishes for the production of laminated plastics; cast resins; oil-soluble resins for paints and varnishes; heat-reactive varnishes for chemical- and corrosion-resistant coatings and linings; plywood bonding materials in powder and liquid form; bonds for abrasive wheels, brake linings; flexible resins for waterproofing cloth, and many other types of materials for specific industrial needs.

Molding Materials. There are two broad classes of Bakelite molding materials—thermosetting and thermoplastic. Each type requires a distinctive molding technic for processing into finished molded products.

Bakelite Thermosetting Molding Plastics. Thermosetting molding plastics are usually fabricated by compression molding in heated molds under pressure. Upon application of initial heat, these materials soften and flux, and, under pressure, fill every crevice of the mold cavity. Upon continued application of heat, they polymerize, or harden into a permently infusible, insoluble state, after which they cannot again be melted or softened with further heating.

Bakelite Corporation produces a wide range of thermosetting phenolic molding plastics, which are produced by the chemical reaction of phenol (and its derivatives) with formaldehyde (and its derivatives).

Phenolic Molding Plastics. Because of their moldability, dimensional stability, excellent electrical insulating qualities, resistance to heat, water, and chemicals, and low price, Bakelite phenolics are notable among molding plastics.

Bakelite phenolic molding plastics may be grouped into four general classes, according to their special characteristics, as follows:

Class 1—General-Purpose Phenolics: Wood-flour-filled materials that provide well-balanced combinations of properties for most general requirements.

Class 2—Shock-Resistant Phenolics: Paper- or fabric-filled materials that offer a wide range of impact strengths in combination with other desirable properties.

Class 3—Heat-Resistant Phenolics: Mineral-filled materials for service at elevated temperatures up to 450° F. for short, intermittent periods of time.

Class 4—Special Phenolics: Materials developed to meet specific service requirements. This group includes low-loss electrical insulating materials, chemical-resistant materials, low-frictional materials, molding boards and blanks, and other special types.

Polystyrene Molding Plastics. Bakelite polystyrene plastics were first introduced for

materials for injection and compression molding. Other thermoplastic mater are covered under the section on Vinylite products. The physical, electrical, chemical properties of polystyrene created an industrial demand for its fabri tion into other useful forms. A few years later special processes were devised fabricators enabling them to produce sheets, tubes, rods, and special shapes fr the base plastic. More recent developments are polystyrene sheeting that sufficiently tough and flexible to permit punching and stamping, polystyr filaments, and polystyrene fiber.

Bakelite polystyrene plastics, in all their fabricated forms, present the produ designer with an unusual combination of properties. Superior electrical insulati values have led to their widespread adoption in high-frequency radio and el tronic service. Remarkable chemical resistance, particularly to strong caustic and acids, has solved problems in chemical processing, handling, and shippin High index of refraction, transparency, and clarity established important us for the material in the lighting field. Good dimensional stability, low specific gravity (1.05) rigidity combined with good mechanical strength characteristic and availability in a great variety of colors, open up many possibilities for im proved product and package design.

Polystyrene molding materials are usually fabricated by high-speed, automati injection molding. The materials are first softened in a heating chamber, the injected into closed molds, under pressure, and quickly hardened into the exact form of the mold by cooling. Sprues, gates, and other sections removed from the parts in the finishing operation can be reworked, thus reducing waste to a mini mum. Polystyrene molding materials can also be compression molded, although injection molding is preferred where high-speed, economical production is neces sary. The materials are supplied in water-clear crystal, as well as transparent, translucent, or opaque colors.

Polyethylene Plastics. Bakelite polyethylene plastics are thermoplastic in nature. They are semirigid, white, translucent materials that can be processed into molding and extrusion compounds, sheeting, film, monofilaments, and solutions. Because they are inherently flexible, they do not require formulation with plasticizers. Dyes and pigments can be added to produce a wide range of brilliant colors.

In general, polyethylene plastics are fabricated by the same means as are other thermoplastic materials, although certain variations in technique are usually required. They can be extruded to form wire insulation covering and jacketing, as well as tubing, rods, tapes, and monofilaments. They can be calendered to form sheeting and film, unsupported or processed with cloth and paper. The calendered sheeting can be planished and embossed. The sheeting also lends itself readily to blow molding, swaging, and cold drawing. These plastics can be molded by conventional compression and injection molding techniques when necessary compensations are made in the mold design for the shrinkage factor.

Laminating Plastics. These are produced by the application of heat and pressure upon superimposed layers of paper, fabric, glass fabric, or other base materials which have been impregnated with heat reactive resin solutions, known as laminating varnishes.

In the process of laminating, the base material is dipped into, or impregnated with, the Bakelite laminating varnish. Layers of the base material are stacked and then subjected to heat and pressure to emerge as a homogeneous solid. The solid can be in the form of sheets, rods or tubes, or can be shaped by a die to some predetermined form.

Laminated plastics divide themselves into three groups, depending on the pressure used in their formation. High-pressure laminates, employing Bakelite phenolic varnishes, are produced under pressures of 1000 to 2000 psi. They are light in weight and strong and make excellent material for table and counter tops, shelving, paneling, silent gears (the material can be readily machined), bearings, and for such formed objects as safety helmets.

It is possible to secure a variety of colors, to use printed sheets for the outside layer for unusual surface effects or to furnish metallic inlays, which add to the usefulness or appearance of the finished product.

Low-pressure laminates can be molded under pressures ranging from 50 to 400 psi. Dies can be made of cast or welded aluminum, wood, cement, plaster of Paris, or combinations of these easy-to-form materials, and usually in combination with a rubber blanket, which forms one-half the die. Thus, this method is used to form many laminated parts where the cost of high-pressure dies would be prohibitive.

In one form of low-pressure laminating, one-half the die is shaped to the part, and is covered by the impregnated laminate—paper, cloth, glass fiber, or asbestos. The other half of the die is a flexible rubber blanket. Forcing the two halves of the die together (by air pressure or by vacuum), the fabricator cures his laminated part by heat.

Both Bakelite thermosetting and thermoplastic resins are available for low-pressure lamination. Such parts as antenna loop housings for airplanes, binocular cases, fuselage steps and doors, and even small boats are produced by this process. Contact pressure laminates use pressures as low as from ¼ to 15 psi.—usually the weight of the die is sufficient. These laminates, chiefly combinations of glass fiber and vinyl or polystyrene resins, offer manufacturing economies, particularly where frequent changes in design prevent standardization. High strength, lightweight laminates, either flat or in three-dimensional shapes, are provided.

Resins for Protective Coatings. Among the major developments of organic chemistry are the synthetic resins that today replace natural resins in the formulation of superior paints, varnishes, enamels, and lacquers. These resins have helped to establish new standards of durability for both air-drying and baking-type coatings. Because they dry to a great extent by polymerization, or evaporation of solvents, rather than by oxidation alone, and possess many other advantages, they make possible the formulation of coatings having remarkable toughness, durability, chemical resistance, water resistance, corrosion resistance, flexibility, adhesion, and greatly increased speed of drying.

The five most important types of Bakelite resins available for paint and varnish formulation are:

Bakelite phenolic oil-soluble resins: For producing top-quality coatings of all types. Outstanding is BR-254, a para-phenylphenol resin. Other 100% phenolic

Bakelite dispersion resins: These resins provide extremely fast-drying coatings with maximum adhesion, toughness, and resistance to salt spray and moisture. Primers air-dry in as short a time as 1 min. to take coats of lacquer or other finishes without lifting.

Bakelite phenolic resin baking coatings: For hard, infusible, and insoluble abrasion-resistant linings for cans, drums, and tanks. Exceptionally resistant to heat, chemicals, solvents, and oils.

Bakelite C-9 resins: For coatings on cloth, paper, concrete, plaster, brick, plastics, wood, and metal. Noted for their adhesion, color stability, and retention of flexibility.

Bakelite C-5 resins: For low-temperature baking white enamels that feature extreme surface hardness, toughness, and depth of luster. Such coatings have excellent color stability, gloss retention, and durability on outside exposure. Bakelite C-5 resins can also be formulated into fast air-drying coatings.

Cast Resins. These materials are supplied in sheets, tubes, rods, or in semi-finished castings. They can be cut, machined, or otherwise worked into finished products with standard tools. Although thermosetting in nature, cast resin sheets can be postformed by special techniques to provide domed and curved surfaces.

Bakelite phenolic cast resins may be grouped roughly under the following classifications:

General-purpose cast resins: Produced in a complete color range, in opaque, translucent, and transparent forms, and in two-tone, mottle, and variegated effects. Available in many stock forms of various sizes, thicknesses, and shapes; also obtainable as special rough blanks for final finishing and assembling.

Special-purpose cast resins: These are specialty resins produced for specific uses, such as parts for light transmission and ordnance equipment, for photoelastic studies in stress and strain analysis, and for varied industrial purposes. One type provides satisfactory containers and laboratory utensils for hydrofluoric acid.

Resin Wood Glues and Impregnants. Wood has been given added strength and durability through the development of Bakelite resin wood glues and impregnants. These materials are divided into three types:

1. Bakelite phenolic resin wood glues: These materials produce a glue line of great mechanical strength and unsurpassed resistance to deterioration. The bond is dense, hard, strong, insoluble, and infusible. It also will resist severe mechanical shock, exposure to weather, and fungus growth.

2. Bakelite urea resin wood glues: These glues provide a low-cost bond of excellent dry strength, good wet strength, and good water resistance. They do not impart the weather resistance offered by Bakelite phenolic resin glues.

3. Bakelite phenolic resins for stabilizing and densifying wood: Stabilized wood veneers and densified laminated woods are comparatively new developments in wood treatment, utilizing to the fullest extent the many important advantages of wood combined with the high mechanical strength and excellent resistant properties provided by Bakelite synthetic resins.

Phenolic Resin Bonding Materials. Resin cements for lamp basing: These resin baking cements are used widely to bond electric light bulbs and radio tubes to

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their metal or plastic bases. The bond is resistant to heat (for ordinary commercial use), and to mechanical shock or vibration.

Bonding resins for abrasive products: These special bonding resins are employed in the manufacture of modern, high-speed grinding wheels used in the grinding and finishing of alloy steels.

Resin cements for bristle setting: These materials provide a tough, tenacious bond for bristles used in brushes of all types. The bond is unaffected by frequent cleaning in water or solvents.

Resins for brake linings: Woven and molded brake linings are made stronger and more resistant to wear, heat, and oil, when processed with Bakelite resins.

Bonding resins for glass and mineral wool: Glass and mineral wool fibers are readily formed into durable, easy-to-handle insulation batts when processed with Bakelite resins. Such products are unaffected by temperature extremes or moisture.

Phenolic Impregnating, Sealing, and Calendering Materials. Calendering and impregnating resins for cloth: Cloth calendered with Bakelite resins acquires a high degree of resistance to water, heat, and chemicals, with little or no sacrifice in flexibility.

Varnished cambrics, made by impregnating fabric with formulations of Bakelite oil-soluble resins and drying oils, are noted for their low power factor, and high dielectric strength at elevated temperatures.

Sealing solutions for castings: Metal castings ordinarily rejected for porosity and small blowholes can be reclaimed by forcing Bakelite sealing solutions into the pores under pressure and then baking. The sealing solution becomes exceedingly hard and tough, unaffected by hot or cold water, steam, oils, chemicals, or heat up to 400° F.

Impregnating varnishes for windings: As protective coatings and insulating bonds for coils, armatures, and windings, Bakelite varnishes remain stable and hard despite elevated operating temperatures and high rotational speeds. Outstanding mechanical strength is also obtained.

Vinylite Brand Plastics. Bakelite Corporation markets Vinylite brand plastics which are produced in a variety of forms from four distinct types of resins—copolymers of vinyl chloride and vinyl acetate, vinyl acetates, vinyl butyrals, and vinyl chlorides. The base resins are thermoplastic powders which are odorless, tasteless, nontoxic, colorless, and nonflammable or slow burning. They can be compounded with fillers, pigments, stabilizers, and plasticizers. Vinylite plastics obtained by such processing can be calendered, molded, extruded, or put into solution to meet an ever-increasing number and variety of industrial and consumer requirements.

Vinylite elastic plastics are vinyl resin compounds that contain a proportion of plasticizer. These thermoplastic materials are flexible. They are tough, and highly resistant to severe abrasion and continued flexing. The thermoplasticity of the compounds contributes to ease of forming into numerous useful shapes. Because they are basically colorless, they can be pigmented or dyed readily to produce transparent, translucent, or opaque articles in an infinite variety of colors, pastel shades, or mass tones.

Vinylite elastic plastics based on vinyl chloride and vinyl chloride-acetate

spread use as insulation for wire and cable. The moisture absorption of the terials is very low, as is their moisture vapor transmission. In general, the terials are resistant to the effects of most chemicals, depending upon the type plasticizer used. The elastic plastics retain their flameproof characteristics wh the proper plasticizer is employed. Because these materials are thermoplast it is not necessary to vulcanize or cure them to produce finished articles. The safe operating range is wide; some types remain flexible at −50°F., and tac free at 200° F.

Vinylite elastic plastics are supplied as molding and extrusion compounds, flexible sheeting and film, and are processed into cloth calendering compounds.

Rigid Plastics. These materials, made from unplasticized resin compounds, a strong, stiff plastics that possess an unusual combination of properties. The rigi plastics are completely odorless, tasteless, and nontoxic, and they will not suppo combustion. Vinylite rigid plastics are noted for their exceptional dimensiona stability. This dimensional stability may be attributed principally to the fac that rigid plastics do not contain fugitive or migrating plasticizers. They main tain their shape and dimensions despite continued exposure to water and humidity fluctuations. They have a low coefficient of expansion and ably withstand tem perature fluctuations provided the maximum temperature does not exceed 55° C Strong and tough over a wide temperature range, tests show that they are sub stantially stiffer than some cellulosic thermoplastics. Water absorption is low only 0.15% after 24 hr. of immersion. They require no curing, and will not war or shrink on prolonged aging.

The rigid plastics are outstanding in their resistance to the effects of practically all chemicals, including concentrated inorganic acids, alkalies, alcohols, and oils. They are affected, however, by certain organic solvents. They have good dielectric properties.

These materials are available as rigid sheets and as compounds for molding and extrusion. The unusual combination of properties inherent in these materials has led to their use in navigational and drafting instruments, packages, records, electrotype molds, toothbrush handles, combs, cosmetic containers, architectural trim, tubing, and many other products.

Molding and Extrusion Compounds

Elastic Compounds. These materials are supplied as granules and as tapes for molding into an infinite variety of forms, or for extruding into tubing, rods, and other shapes, or into continuous insulating coverings for wire and cable. They can be molded by any of the standard plastic molding processes, although the injection molding process is most commonly used. They can be extruded on standard plastic extruders. The molding granules are available as transparent, translucent, or opaque materials, either colorless or in a wide variety of standard and special colors. The extrusion materials are provided in transparent, translucent, and opaque colors, usually in tape form, though a few of the materials are supplied in granular form.

Rigid Compounds. Vinylite rigid molding compounds are suitable for both compression and injection molding. The extrusion compounds are adaptable to fabrication on standard plastic extrusion machines. The color range of the compounds is broad, and the compounds may be transparent, translucent, or opaque as desired.

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The exceptionally low mold shrinkage of Vinylite rigid plastics—0.001 to 0.003 in./in. maximum—results in greater dimensional accuracy, excellent size control, and more accurate reproduction of the mold. Moldability around metal inserts is another equally important advantage.

The extrusion compounds can be formed into any shape for which it is possible to design a die. This fact, plus the unlimited color range, provides extremely wide latitude in design possibilities.

Vinylite Calendered Film and Sheeting

Flexible Sheeting and Film. These materials are produced in translucent, transparent, or opaque forms, clear and colorless, or in an extensive range of colors. They are obtainable in varying thicknesses and widths either in a calender finish, or press-polished effects obtained by plenishing. The materials lend themselves readily to embossing. It is also possible to decorate the materials with colored stripes. The thin films can be laminated on both sides of delicate fabrics such as lace and voile to impart greater usefulness and durability to the fabric.

These flexible plastics can be bonded to themselves or to other materials by various heat-sealing methods, or through the use of modern resin adhesives. The materials can be formed into simple shapes. They can also be cut, stamped, and sheared with standard tools.

Rigid Sheets. Vinylite plastic sheets are supplied in a range of thicknesses, from 0.010 in. to 0.125 in., in a standard sheet size of 20 in. by 50 in., with a matte or press-polished finish, or in continuous calender-finished rolls or sheets, 0.005 to 0.015 in. thick.

These sheets can be formed and shaped under heat as desired. They can be drawn, blown, spun, swaged, or formed around a mandrel into complicated three-dimensional shapes. They can be punched, sawed, sheared, and machined on standard metal-working equipment. Permanent bonds are secured readily by solvent sealing. Close-register multicolor printing is possible on their surfaces, for there is no shrinkage or expansion with changes in atmospheric humidity.

Resins for Protective Coatings

The properties of the vinyl chloride-acetate resins make them especially suitable for surface coating applications. When correctly formulated and applied from solution in organic solvents, they yield finishes which are unusually tough, glossy, adherent, and resistant to chemicals. They may be applied to a wide variety of surfaces, such as metal, concrete, wall tile, glass, and wood. Their use on cloth or paper is outlined below.

In general, protective coatings based on these resins dry by the evaporation of the solvent. Both air-drying and baking-type finishes can be produced. Baking is used to develop maximum adhesion and chemical resistance, and to accelerate the release of solvents. These coatings, baked on sheet metal, have such excellent adhesion and toughness that parts may be stamped, spun, or drawn from the coated sheets without cracking or rupturing the resin film.

Surface coatings based on Vinylite resins are available from a number of paint and lacquer manufacturers. These coatings can be applied by spraying, roller coating, dipping, or brushing.

The various finishes based on these resins are suitable for such uses as linings for food and beverage containers; stop-off lacquers in electroplating; finishes for concrete, cement, asbestos, and alkaline wallboards; and coatings on metal sheets that are subsequently formed to shape. Vinylite resin coatings are odorless, tasteless and nontoxic. They have extreme chemical inertness; water resistance, toughness and flexibility; nonflammability; water-white color, good clarity, relatively high refractive index; and resistance to aging and weathering.

Vinylite organosols consist of extremely finely divided particles of resin suspended in nonsolvent media. They differ markedly from true solutions of resins in active organic solvents. They produce tough, chemically resistant, insoluble coatings at extremely low costs. The coatings deposited from dispersion compounds, can be hard or rubbery, heavy or light, clear or pigmented in any color desired. Like other vinyl baking finishes, they serve a variety of applications to which they contribute such advantages as low cost, high solids, and easy handling.

Vinylite brand plastisols are dispersions in which the liquid medium consists entirely of plasticizers which become active solvents for the resin only after the application of heat. They offer a new approach to the molding of elastomeric vinyl compounds. Because they may be handled in a fluid state, they eliminate the expense of injection molding machines and heavy molds.

Vinylite plastisols are finding commercial applications for numerous specialty molding jobs where their ability to be molded without pressure; to be injected without damaging delicate inserts; to fill long molds without weld marks or strains is very important. Their other important uses include tape impregnants, repair pastes for vinyl insulated wire, and special types of sealing, coating, and gasketing applications.

Strip coatings, based on Vinylite resins, form a continuous film of low adhesion so that they may be stripped from the surface below without damaging it. They are air-dry surfacing materials which do not require heat treatment or baking to fuse them. These strippable coatings can be applied by either the dip, spray, or brush method. Strong and durable, they afford maximum protection against weathering, corrosion, mechanical abrasion, and scuffing.

Vinylite Resins for Cloth and Paper Coatings. Cloth coated with Vinylite resin is produced by practically all manufacturers of coated fabrics. Following the coating operation, the material, in whatever color desired, can be pressed between polished steel plates, or embossed in any conceivable design to produce an extremely wide variety of surface effects. These materials are of particular value as upholstery which must be subjected to severe usage; as raincoats; as shoe uppers; or as any other product which must be subjected to sunlight, moisture, or continued flexing.

Paper, coated with Vinylite resins, presents the product design engineer with an extremely useful packaging material. In this instance, the coating compound is usually clear and transparent, and the color or design is provided by coloring or printing the paper to be coated. The ease of fabricating paper that has been

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sealing operation will form a package which is completely water resistant, grease resistant, tasteless, and nontoxic, and which will protect its contents for long periods of time.

Adhesives and Bonding Materials

Vinylite resin adhesives are characterized by unusual toughness, flexibility, and resistance to impact. The vinyl acetate and modified vinyl acetate resins are the types most generally used. These thermoplastic materials are colorless, odorless, tasteless, nontoxic, and slow burning. They are soluble in a wide range of organic solvents, and are compatible with many plasticizers and a number of other resins and gums which can be added to modify their properties for specific applications.

Vinyl acetate resin adhesives are extensively used as bonding agents for many materials, including cellophane, cloth, paper, cardboard, porcelain, metal, mica, stone, leather, wood, and plastic sheets and film. When bonding nonporous materials, advantage is often taken of the thermoplastic nature of the resins. After coating the surfaces to be bonded, the resin film is dried and the two pieces are then laminated under heat and pressure.

Vinylseal brand adhesive solutions based on modified vinyl acetate resins are especially recommended for bonding impervious materials, such as metals, and urea and phenolic plastics. These adhesives possess greater adhesion and impact strength than those based on the unmodified vinyl acetate resins. Bonding strength is comparable to that obtained with soft solder.

In addition, another type of Vinylite brand bonding plastic is available in the form of flexible, highly plasticized sheeting. This material, a vinyl butyral product, was developed by Carbide and Carbon Chemicals Corporation in 1936 to serve as the heat-sealing interlayer for high-test safety glass. It is adaptable to the bonding of many other materials.

Special Products

In addition to the elastic and rigid plastics, coating products, and adhesives already described, three types of "special" products are produced from vinyl copolymer resins.

Vinylite laminating film is produced with various degrees of flexibility, and possesses properties intermediate between rigid sheets and highly plasticized sheeting. It is applied as a protective and decorative film to wood, cloth, paper, leather, and other surfaces by the application of heat and pressure. It also serves to heat-seal labels and insignia on cloth.

Vinyon brand fiber is chemically inert, permanently water resistant, and mildewproof, and is nonshrinking below 150° F. It has high tensile strength, and true elasticity comparable with silk. Surface wetting may be accomplished by the use of wetting agents. The yarn will not support combustion. Further, it is not attacked by bacteria and fungi, and will not support such growths.

The Barrett Division, Allied Chemical & Dye Corporation

Cumar is a synthetic resin known technically as paracoumarone-indene resin, first produced in the United States by the Barrett Company. Cumar is manu-

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