# CERAMIC ABSTRACTS

## 1963



Compiled by
The American Ceramic Society, Inc.
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PLAINTIFF'S EXHIBIT
CAM-161

**Crystal growing process.** Allan I. Bennet (Westinghouse Electric Corp.). U.S. 3,058,915, Oct. 16, 1962. D.J.B.

**Device for X-ray spectrochemical analysis by means of fluorescent radiation.** Sjoerd Wytzes (North American Philips Co., Inc.). U.S. 3,060,314, Oct. 23, 1962. D.J.B.

**Electrochemical determination of fluorides.** George H. Farrah (Aluminum Co. of America). U.S. 3,058,901, Oct. 16, 1962. D.J.B.

**Growing single crystals from a molten mass with a linear isotherm.** Juraj Eckstein and Zdenek Wachtl. Czech. 94,-996, April 15, 1960; *Chem. Abstr.*, 55 [3] 2217g (1961).

**Method and apparatus for the continuous colorimetric determination of the individual components of a [liquid] mixture.** Wolfgang Grassmann and Kurt Hannig. U.S. 3,059,524, Oct. 23, 1962. D.J.B.

**Method and apparatus for operating an analytical mass spectrometer with a getter-ion pump.** Ernest W. Boyer (Conti Oil Co.) U.S. 3,057,996, Oct. 9, 1962. D

**Method for the growth of preferentially oriented single tals of metals.** Theodore H. Orem (United States of A as represented by the Secretary of Commerce). U.S. 3,0 Oct. 23, 1962. D

**Process for separating rare earths and yttrium by ion exc [resin].** Pawel Krumholz and Kasimierz J. Bril. U. 054,655, Sept. 18, 1962. D

**Treatment of zeolitic molecular sieves to inhibit polymer of olefins.** N. V. de Bataafsche Petroleum Maatsc Brit. 842,431, July 27, 1960; *Chem. Abstr.*, 55 [2] 1968 (196

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See also Sect. V: Elastic stresses produced by indenta plane surface of a semi-infinite elastic solid by an elastic sp punch.

## XV—General

**Glass dust—a study of its biologic effects.** P. Gross, Marian L. Westrick, and J. M. McNerney. *A.M.A. Arch. Ind. Health*, 21, 10–23 (Jan. 1960); *APCA Abstr.*, 5 [10] 7 (1960).—A study on animals showed no effect of glass dust and glass flakes on the conjunctiva. No toxic or traumatic effect was demonstrable on the gastrointestinal tract. There was no bronchial disease attributable to the dust. Compared with kaolin, fine glass dust was even more benign in pulmonary effects because the stored dust remained alveolar instead of occupying interstitial positions and therefore was more readily mobilized and cleared from the lung.

**Histology of iron deposits in silicosis among porcelain workers.** H. Otto and R. Maron. *Arch. Gewerbepathol. Gewerbehyg.*, 17 [2] 117–26 (1959); *APCA Abstr.*, 5 [8] 9 (1960).—Earlier work indicated that normal lungs had an iron content, measured as $Fe_2O_3$, as high as 3.4 g with an average of 0.3 g. Similarly measured, the content of the lungs of persons who had worked in dusty industries ranged from 0.4 to 10.0 g. The authors made a histological and histochemical study of 40 cases of porcelain silicosis. The iron reaction was typical only of severe siderosis; in a low-grade silicosis with predominantly tubercular damage, the iron reaction was correspondingly slight, indicating a possibility of the use of this reaction in a differential diagnosis.

**Hygiene characteristics of mica dust.** I. K. Pushkina. *Gigiena i Sanit.*, 25 [8] 18–23 (1960); *APCA Abstr.*, 6 [11] 2 (1961).—X-ray examinations of workers at industrial plants using mica indicate the possible occurrence of chronic lung diseases of pneumoconiotic etiology.

**Impact of materials science and materials engineering on ceramic engineering.** Joseph A. Pask. *Am. Ceram. Soc. Bull.*, 42 [1] 23–24 (1963).

**Methods of preparation of silica-containing dusts for use in biological research.** E. Occella and G. Maddalon. *Med. Lavoro*, 52 [5] 382–90 (1961); *APCA Abstr.*, 7 [12] 5 (1962).—The mineralogy laboratory of the Clinica del Lavoro of Milan Univ. has prepared a series of samples of fine silica-containing or inert dusts, classified and defined granulometrically, for the study of the etiology of silicosis. The origin and synthesis of the prime materials (quartz, opal, diatomaceous earth, chalcedony, tridymite, cristobalite, silica glass) are reviewed, together with grinding techniques and methods of classification used to obtain dusts mostly $<3\mu$ in diameter.

**Pathogenicity of glass reinforced plastics—experimental inquiries by injection or external application techniques.** G. W. H. Schepers. *Arch. Environ. Health*, 2 [6] 20–34 (1961); *APCA Abstr.*, 7 [4] 7–8 (1961).—The tissue damaging effects of flake glass and of two varieties of Fiberglas plastic with a calcium carbonate filler were explored. Although all these substances are comparatively inert, the Fiberglas plastic with a calcium carbonate filler produced slightly more local reaction th with a calcium sulfate filler. Flake glass had the least None of the substances caused fibrosis except Fiberglas inj subcutaneously.

**Plant organization for quality control.** C. F. Fitz *Can. Ceram. Soc.*, 31, 104–105 (1962). J

**Production of antibodies by quartz and beryllium** A. Collet, G. A. Voisin, and F. Toullet. *Arch. Environ.* 2 [4] 409–17 (1961); *APCA Abstr.*, 7 [1] 6 (1961).—Three of guinea pigs were used: a control group, a group give tions of quartz + homologous cells + homologous serum group given injections of beryllium oxide + homologous homologous serum, according to the usual method for i immunization. The results showed that no antibodi formed against the substances tested. None of the animals showed hypersensitivity to quartz, BeO, or bot serum. A moderate hypersensitivity was produced animals of the two treated groups for homologous poly leukocytes.

**Some oxidative and hydroxylative actions of quart possible relation to the development of silicosis.** L. W. and J. S. Harrington. *Nature*, 188, 1173–74 (Dec. 31 *APCA Abstr.*, 7 [1] 7 (1961).—The existence of a special activity possessed by siliceous dusts and silicates has l ported. A correlation appears to exist between the o activity of the dusts and the known fibrogenetic potenti materials examined. A connection between particle activity also seems apparent in coarse quartz and othe dusts of a smaller size.

**Sudan's ceramic industries.** A. Lee Bennett. *News*, 11 [8] 14–15 (1962).—B. describes the manufa brick and sewer pipe in open-air plants near Khartoum.

**Types of asbestos, their study by optical methods, a pathogenic action.** K. G. Schmidt. *Staub*, 20 [6] (1960); *APCA Abstr.*, 7 [1] 4 (1961).—With the pol and phase contrast microscopes it is comparatively distinguish eleven types of asbestos. Chrysotile, amo crocidolite asbestos are dangerous, and tremolite or an lite may cause illness. Too little is known about t types. All asbestos dusts should be treated as being inj the lungs.

PATENT

**Light-scattering coatings for the inside of light bulbs** W. Hoaijman, Gerardus H. Janssen, and Petrus C. Linden (N. V. Philips' Gloeilampenfabrieken). Dutc April 15, 1959; *Chem. Abstr.*, 55 [5] 4914e (1961).

## XVI—Books

**Advances in X-Ray Analysis: Vol. 5, Proceedings of the Tenth Annual Conference on Applications of X-Ray Analysis, August 1961.** Edited by William M. Mueller. 1962. Plenum Press, New York 11. xi + 584 pp., illus. $17.50.—This volume ... after the actual conferences. Many of the papers deal with work in progress rather than with complet tigations, and in the discussions which are recorded, su agree that their work is nowhere near completion. T sions make very interesting reading, in some cases l

Soda ash improves the quality of both the brick and the hollow tile.

Experience at this plant has emphasized an even more interesting point, namely, the property of soda ash of depressing the maturing temperature in firing. The material used has an extremely narrow firing range; about six courses of brick in the bottom of every kiln were formerly so light colored and soft as to be practically unsalable. With soda ash, two different percentages of treatment are used; the heavier treatment is used on the required proportion of the production to set six courses in each kiln, and certain tunnels in the drier are reserved for these brick. These brick are also identified by a scratch mark on the back. Instead of the capacity of each kiln being cut approximately 4500 brick, the kilns now turn out their full capacity of fully fired brick; the brick from the lower courses are as dark and hard as those from the higher courses. The shrinkage, furthermore, is as uniform as the color. The probable usefulness of such a procedure in other plants, in regard to production as well as cost and quality, is interesting.

Another application of this same procedure suggests itself for plants where slight or no actual losses occur through underfired brick in the lower portions of the kilns. If the maturing temperature of ware in selected portions of the kiln may be reduced by similar differential soda ash treatment, over-all firing time may be reduced. Less heat and consequently less time will be required to mature the lower courses of brick which carry the heavier soda ash treatment. Time saved at the last end of a firing leads to worth-while fuel saving, and any saving of firing time is automatically an increase in firing capacity.

### VI. Conclusion

The foregoing examples are typical results obtained by the use of soda ash in the Barker-Truog process and represent a wide variation of raw materials and plant procedure as well as of geographical location. Development along the lines discussed was never of greater importance than at the present time when high-quality production at minimum cost is urgently needed.

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# FIBERGLAS: SOME PROPERTIES AND NEW APPLICATIONS*

By F. V. Tooley

**Abstract**

Fiberglas is produced in two basic forms, namely, as a wool and as a textile. There are three varieties of wool: (1) thermal-insulation wool, the starting point for a large number of insulation products; (2) bonded mat wool, used in the form of a retainer mat in electric storage batteries; and (3) air-filter wool, used in the cleaning and conditioning of air. Textile fibers are of two types, continuous and staple. These two types represent starting points in the construction of numerous yarns, tapes, and fabrics used for electrical insulation and chemical filtration purposes. Other applications range from use as wicking for oil lamps and stoves to use as a pipe lagging material. The versatility and utility of Fiberglas are a consequence of the chemical and physical properties of the original basic fibers and the high adaptability of the fibers for predetermined orderly organized arrangement. Fiberglas can be used profitably wherever (1) electricity is generated, transmitted, or used, (2) air is cleaned or conditioned, (3) heat is conserved, controlled, or excluded, and (4) fabrics are needed to withstand heat, rot, dampness, decay, or chemical attack. New and future applications of Fiberglas include its use or development as (1) a wicking in combination with peat moss to feed solutions, through controlled capillarity, to the roots of growing plants; (2) a combination insulant and surface finish in the form of a new strong, rigid, lightweight board; (3) a new low-temperature insulating medium in the form of an asphalt-enclosed rigid bat; (4) a surgical suture and tracer yarn in surgical sponges; and (5) a decorative fabric. Used as an effective replacement material for cork, nonferrous asbestos, aluminum, and mica, Fiberglas is becoming increasingly important as a strategic material.

### I. Introduction

Knowledge of new materials, of the jobs they will do, and how they will do them is an all-important factor in making the most effective use of research, engineering, and designing time. There are many materials for which such information could profitably be summarized at the present time. This is particularly desirable in the case of Fiberglas because of the rapidly expanding scope of its application and the attendant difficulty of keeping the technical man informed as to what this unique material can do or is doing technologically. In 1931, there was but one Fiberglas product; today, 350 separate Fiberglas products are manufactured, and large quantities of basic fibers and yarns are contributing to the value of a wide variety of independently manufactured articles.

Glass is an old and faithful servant of mankind, and in this fibrous form, relatively new on the industrial scene, it continues to fulfill its traditional role.

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### II. Basic Fibers and Yarns and Their Production

There are two basic forms of Fiberglas, viz., a wool form and a textile fiber form. The wool form may be further subdivided into three elemental fibers: (1) a fine form used most generally for thermal insulation, (2) a slightly coarser form used as a retainer mat in electrical storage batteries, and (3) a much coarser form used for air filtration in air-conditioning systems. The first of these is the starting point for a large variety of insulation products. Textile fibers likewise exist in two elemental forms, viz., the continuous fiber and the staple fiber, which are used in building up a large number and variety of yarns and threads that are subsequently woven into fabrics of wide utility. Both fibers are much finer than the thermal wool fibers.

All of the basic fibers are produced by the attenuation of molten glass as it issues from small orifices at the bottom of glassmelting tanks or furnaces. In all varieties of wool and staple textile fibers, the attenuation is produced by high-pressure jets of steam or air; the attenuation of continuous fibers is produced by mechanical drawing at high speeds.

#### (1) Wool Fibers

Wool fibers are collected on a traveling conveyer which carries the pack through a series of automatic operations, the nature and number of which depend on the particular type of product to be made. These processes include fiberization, the application of a binding agent, compression to desired density, the curing of the binding agent, the application of special adhesives and coverings to facilitate handling, and cutting to desired size. Some of the products are complete for use as they are taken from the conveyer. The material often is but semiprocessed, however, and it serves as a raw material in the building of other products (see Sections III and IV).

The wool process consists of a standard glass-tank operation in which the batch is charged in a conventional way at one end of the tank and glass wool fibers are produced at the other. Both the staple and continuous processes differ from the wool process in that each involves the use of glass cullet in the form of marbles. The glass marbles are inspected carefully before they are remelted in special electric furnaces.

#### (2) Staple Fibers

Staple fibers are collected in the form of a web of interlaced fibers, on a traveling belt from which they are subsequently gathered without twist, as a sliver (pronounced slyver). Staple fibers average 8 to 15 in. in length; the most common variety averages about 0.00027 in. in diameter. More recently, both larger and smaller fibers have been needed, and they have been produced for special purposes. A slight draft is given to the sliver in the gathering operation to orient the majority of fibers in parallel fashion. All staple fiber rovings and yarns are in turn derived from this original staple sliver.

#### (3) Continuous Fibers

Continuous fibers are made by a different process. The individual filaments, 102 or more, are continuous in length. When they are gathered into a strand, they are drawn mechanically on a spindle which travels at a speed of a mile a minute or even higher. Lengths of the filaments are limited only by packaging requirements. The individual filaments in the most commonly made continuous strand are 0.00022 in. in diameter, although here again this diameter can be varied considerably on either side according to the characteristics desired in the final product.

Small amounts of lubricants and coatings are used on both the staple fibers and continuous filament strands. These materials, usually starch or vegetable and mineral oils, facilitate the forming operations and keep the individual glass filaments from rubbing together. This application is important, for the strength of glass fibers is reduced if the surfaces of the fibers become scratched.

#### (4) Yarns

The yarns that go into the manufacture of fabrics are built up from the original staple slivers and continuous filament strands on standard textile machinery, the latter requiring but slight modification. Original continuous strands are twisted and plied together to give any desired yarn construction, the latter depending on the service function to be fulfilled. Ordinarily, yarns will consist of from two to twenty original strands, and the heavier constructions commonly involve as many as ten separate twisting and plying operations.

The original staple sliver is converted into yarn by a drafting and twisting process patterned after worsted yarn methods. Yarns of various degrees of fineness are produced; the degree of drafting is governed by the desired fineness. The coarsest staple yarns are made without drafting.

### III. Properties, Products, and Applications

#### (1) Properties

The great utility and versatility of Fiberglas arise from two fundamental sources, viz., (1) the physical and chemical properties of the glass from which the basic fibers are made and (2) the adaptability of the fibers to organized formation and arrangement which makes possible the building up of derivative products of prescribed and exacting specifications.

Reduced to fibers, the properties that characterize glass in general are retained, although some properties are modified considerably. Brittleness disappears as a practical consideration and is replaced by flexibility and resiliency. The tensile strength of glass increases extraordinarily as the size of the unit or, in this case, fiber is decreased. Fibers with calculated tensile strengths as high as 2,000,000 lb./sq. in. have been produced in the laboratory. Fibers of a size used in regular continuous-filament production show tensile strengths of around 300,000 to 500,000 lb./sq. in., a value considerably more than the tensile strength of hard-drawn steel piano wire.

Glass fibers are incombustible, a property which is of extreme importance in practically all applications from the safety standpoint. High-heat and electrical resistance are responsible for the wide applicability of Fiberglas in the electrical field. Tapes, yarns, and fabrics used in the electrical industry can safely withstand temperatures up to 1000°F.

The electrical properties of glass are retained in fiber form and are augmented by the use of glasses substantially free of Group I alkalis. Fiberglas electrical tapes combine high dielectric strength and electrical insulation resistance with extremely low moisture absorption.

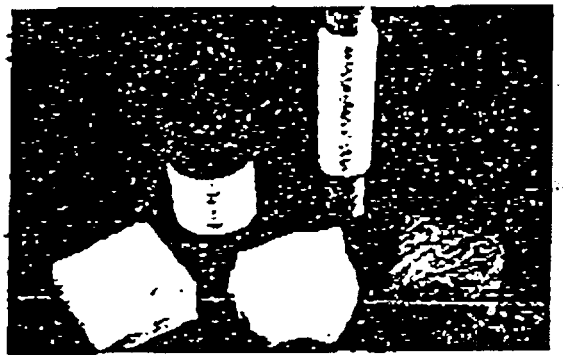

FIG. 1.—Basic fibers used in the production of Fiberglas products. Top row (*left to right*): continuous filament strand and staple sliver; bottom row (*left to right*): insulation wool, bonded mat fiber, and air filter wool.

FIG. 2.—Carefully inspected marbles used in the manufacture of textile fibers.

Chemical durability becomes of increasing importance when the glass surface is increased by fiberizing. A degree of attack which would be negligible in a large article is a serious matter with a small fiber, so special glasses must be employed according to the service conditions to be encountered.

The thermal and air-filtering properties of Fiberglas result from its general fiber form and adaptability to formability and organized arrangement. In the case of thermal-insulation wool, this adaptability makes possible the formation of a fiber mass with a maximum of dead air spaces. In the case of air filter wool, a structure with adequate strength having an extended surface for the application of the dust-catching adhesive, low resistance to the passage of air, and high-heat resistance is made possible. The properties of incombustibility and durability are here again of great advantage.

(2) Products and Applications

As a general statement concerning the applicability of Fiberglas, it may be said that this versatile material can be profitably used wherever (1) electricity is generated, transmitted, or used, (2) air is cleaned or conditioned, (3) heat is conserved, controlled, or excluded, or (4) fabrics are needed to withstand heat, rot, dampness, decay, or chemical attack.

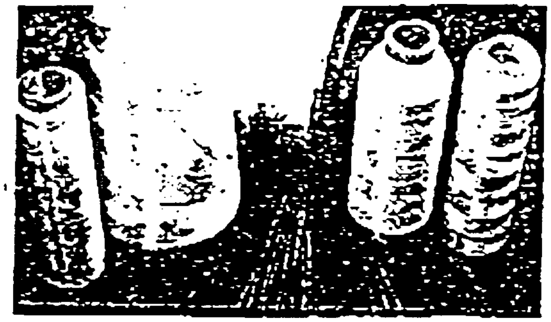

FIG. 3.—Continuous filament yarns on various types of packages

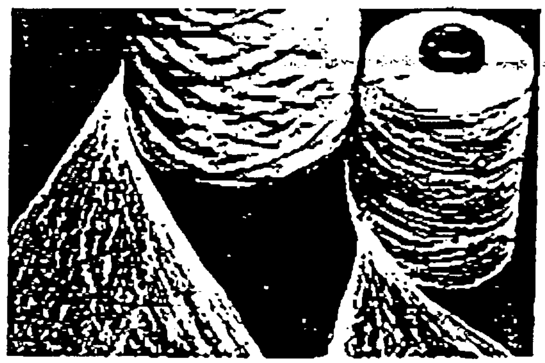

FIG. 4.—(*Left*): plain staple fiber as gathered on the forming tube; (*right*): low-twist staple yarn reinforced with continuous filament yarn.

The electrical industry is the chief user of Fiberglas in its textile form. It is used widely as tapes, cloths, braided sleevings, and tying cords for the insulation of electric motors, generators, transformers, and other types of operating and distributing equipment. Because relatively thin layers of glass tape will insulate well and because its remarkable resistance to heat will allow motors to operate at much higher temperatures than when alternate insulation materials are used, Fiberglas offers the advantage of weight and space savings, higher operating efficiency, and lower equipment maintenance costs when used with suitable varnishes and impregnants and in accordance with sound engineering techniques.

In the chemical field, glass fabrics are being used as (1) chemical filtration cloths, especially under conditions involving corrosive liquids or gases at high temperature, and (2) anode bags for electroplating processes. Miscellaneous industrial uses of Fiberglas fabric range from pipe lagging and facings for insulation block to wicks for kerosene or oil lamps and stoves.

Fiberglas thermal-insulation wool is processed into many forms to make it more adaptable for particular uses.

Density, degree of flexibility or rigidity, external form, and surface condition can all be varied to suit the application. Thus the material is prepared for home and industrial purposes not only in the form of a fleecy white wool of 1½ lb. per cu. ft. density, but also in flexible-to-rigid sheets, metal-mesh and sewn blankets, blocks, and boards of predetermined specifications, which are used for insulating all types of industrial equipment in all temperature ranges from subzero to 1200°F., according to the product. Standard sizes and thicknesses of sectional pipe insulation are also fabricated from the original basic thermal-insulating wool fiber.

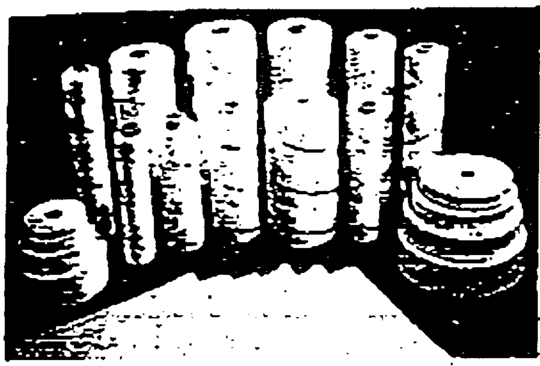

**Fig. 5.—Fiberglas sleevings, tying cords, electrical insulating tapes and cloths, and chemical filtration cloths. These illustrate only a few of the end products built from the original textile fibers by a succession of twisting, plying, weaving, and braiding processes.**

In these different products, Fiberglas thermal-insulating wool fulfills the necessary requirements for a good industrial insulation, namely, low thermal conductivity, fire safety, enduring resistance to vibrations and settling, lightness in weight, cleanliness, and durability.

Bonded mat fiber finds its greatest use as retainer mats in storage batteries. These mats greatly extend battery life by keeping active material in place on the battery plates. They can serve this purpose because the glass employed in them is resistant to attack by the battery acid and has good electrical insulation characteristics. Bonded mat products have been used less extensively as a light-diffusing medium, as an inorganic facing material, and as a coating for underground pipes to combat electrolytic corrosion.

In the field of air conditioning, the adaptability of Fiberglas to organized arrangement is again recognized. The filter units for removing dirt, lint, soot, plant pollens, and similar nuisance dusts from the air are built up of a series of filter mats which differ in the sizes of fibers used in their construction. The individual fibers are coated with a dust-catching adhesive. This orderly arrangement allows a large surface contact in a limited space and offers relatively low resistance to the passage of air. These combined properties mean, on integration, a high capacity for cleaning air.

## IV. New and Future Applications

New effective Fiberglas products and applications are gradually finding their way into industry and others will soon appear.

Some of the new developments are improvements on old products, and in general these depend on the important Fiberglas property of adaptability to orderly, predetermined arrangement. Such a development is the reinforced staple sliver. The incorporation of a continuous strand in the staple sliver during forming or twisting prevents further drafting and yields a product which is an effective filler for electrical cables.

Other new developments have grown out of newer methods of processing and application which take fuller advantage of certain desirable properties.

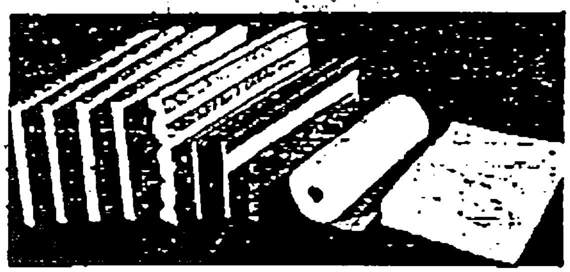

**Fig. 6.—Some products derived from insulation wool and a roll of bonded mat fiber frequently used as a facing material.**

An interesting new application of Fiberglas is in the field of hydroponics, where effective use is made of its heretofore relatively obscure property of controlled capillarity. Glass-tape wicking in combination with peat moss feeds chemical solutions to the plant roots at a fixed rate.

Fiberglas thermal-insulation wool is the raw material used in the production of a new strong, rigid lightweight insulation board by a newly developed process that combines pressure and a carefully controlled heating cycle to increase the density of the material without loss of resiliency. This board, used largely as a combination insulation and surface finish, releases for other purposes large quantities of aluminum formerly used as a facing material over Fiberglas insulation wool.

Developed to replace cork for low-temperature insulation, Fiberglas AE board, a rigid bat of insulation wool enclosed in asphalt, is being widely used in domestic food-storage lockers and in other large-scale refrigeration units.

In the field of medicine, Fiberglas is undergoing thorough investigation as a surgical suture[1] and as a tracer yarn in surgical sponges.[2] In addition, Fiberglas tape is being used to filter blood plasma in army field kits.[3]

Both bonded mat of the type used in batteries and chemical filter cloth have been used quite successfully in

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[1] Roy P. Scholz and Philip S. Mountjoy, "Fiberglas Suture Material," *Amer. Jour. Surgery*, 56 [3] 619–21 (1942).

[2] Edward F. Lewison, "Rayable Gauze as a Factor of Safety in Surgical Operations," *Bull. Amer. Coll. Surgeons*, 27 [1] 39–40 (1942).

[3] "New-Type Plasma Filter Will Aid in Prevention of Fatal Wound Shock," *Surgical Business*, June, 1942.

laboratories as filtering pads in Büchner funnels when the solutions being filtered were destructive to ordinary papers.

Many decorative applications of Fiberglas have been developed in the past, and this development undoubtedly will proceed at some more appropriate future time. Various colored damasks, brocades, satins, taffetas, and nets have been well established, and products made from these include overdrapes, glass curtains, shower curtains, bedspreads, tablecloths, and lamp shades.

### V. Role of Fiberglas in the War Emergency

Used as an effective replacement material for cork, nonferrous asbestos, aluminum, and mica, Fiberglas is becoming important as a strategic material in the war program. Electrical manufacturers and design engineers have achieved savings in both space and weight in new electrical equipment through the use of Fiberglas electrical tapes and cloths. Fiberglas is taking the place of cork in certain types of low-temperature insulation. It is also combined with mica in the manufacture of ground insulation for electrical equipment, thereby reducing considerably the quantity of mica required.

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# MODELING SHEET GLASS IN A POTTERY KILN*

By Dolly M. Ernst

Abstract

A method is described for obtaining relief pattern in sheet glass while bending it into decorative and usable forms.

The fact that sheets of glass may be bent in a ceramic mold in a pottery kiln has been discovered in the Ceramic Laboratory of the University of Cincinnati. When the glass is cooled, it has an appearance quite different from the crisp perfection of glass bent in the smooth metal molds used commercially. It is more like old hand-rolled glass.

The tendency of the heated glass, as it bends to the shape of the mold, to pick up impressions of each minute raised particle may be developed into impressions of definite, calculated relief patterns.

The process is simple. Molds are made of clay, the design is modeled thereon, and they are biscuited. A wash of clay and flint (25 and 75%, respectively), plus a little gum tragacanth, is applied to the mold to prevent the glass from adhering to it. A clean sheet of glass cut to fit the outer contour of the mold is placed on it, and it is ready to be put into the kiln. The temperature is brought up slowly to a point just sufficient to cause the heated glass to move down. It sinks as a heavy film, finding the various levels of the modeled surface.

The temperature required varies with different glass compositions. Experimentation is necessary to find the temperature best suited to the type of glass being used. It will probably be around cone 01Z, or 1544°F. Proper regulation of temperature is required because heat that is too high or that is maintained too long will cause the surface to slip or to devitrify.

The kiln must be cooled slowly to anneal the glass, as rapid cooling to rigidity will create strain.

The upper surface of the molded glass will be smooth and will need no further attention. The under surface, however, will require cleaning inasmuch as some of the kiln wash may be picked up. A mild abrasive and a wet brush may be used, but neither should be hard enough to scratch. A silicon carbide stick may be needed to smooth the edge if the firing has been too drastic.

To find the full extent of the ups and downs that the glass will take, a coarse clay has been used for the forms, because the chance of cracking or breaking is lessened if designs are worked out in high relief. This explains the pebbled texture of some of the pieces. The porosity of the biscuit causes the kiln wash to dry with a pebbled surface.

The type of modeling also affects the success of the impression. The heavy creeping mass of heated glass has a tendency to slide over the crevices. Definition is given by a calculated change in form that checks this viscous flow an instant, giving an accent where it is needed; otherwise, the pattern may show as a lot of meaningless bumps in the glass. The exact reproduction of designs pressed into a mold in the traditional manner should not be expected or attempted.

The outer contour should be controlled by designing the mold so that a support for the edges of the sheet of glass is provided or warpage may occur if the heat of the kiln is uneven. Small holes may be drilled in the deep crevices if the modeling is in quite high relief to expel any trapped air that may cause a bubble in a reverse direction.

A surprising amount of modeling is possible. A variety of different impressions may be made from the same mold by using different foreign and domestic glass compositions. Single- and double-strength window glass is used for small molds; crystal and plate glass are used for large molds. All types of glass bend satisfactorily; the temperature required, of course, varies.

Other experiments have consisted of stacking layers of glass together. Glass, cut in triangles, squares, etc., and placed in pattern on flat sheet glass laid on a mold fuse together as the glass bends to the mold. When various-colored glasses are combined, chipping and crazing occur if the formulas are not "sympathetic." Design possibilities are limited, owing to glass-cutting difficulties. Overglaze ceramic colors applied on a flat sheet in the same manner as glass enamels also bend with the glass.

Ceramic molds are durable in a commercial, moving, circular kiln. Glass bends satisfactorily in an undecorated mold, but few perfect impressions are obtained from the decorated molds. A pottery kiln gives a better texture to the glass.

The materials needed for the modeled bent glass are inexpensive, and, aside from a pottery kiln, little equipment is required.

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* Presented at the Forty-Fourth Annual Meeting, The American Ceramic Society, Cincinnati, Ohio, April 21, 1942 (Art Division). Received September 15, 1942.