Statement on the PFAS ban of selected ÖkoMatBatt project partners

PFAS (perfluorinated and polyfluorinated substances) are currently indispensable as a class of materials from the point of view of energy storage. They are used at various interfaces in lithium-ion batteries, as binder components (PVDF, PTFE), as active electrolyte salts (e.g. LiTriflate, LiFAP, etc.) and as additives (LiTSFI) in the electrolyte. Especially in lithium-ion batteries, they form an established and safe use as binder components, which have been industrially produced and processed for many years. At present, there is no substitute that could completely replace this material in terms of process and product safety for all battery types. The potential requirements for the polymer are very demanding for this application. It requires the appropriate thermal and electrochemical stability and piezoelectric properties within the cathode structure. To date, no material is known that covers all these properties to the same extent. Polyvinylidene fluoride (PVDF) has unique electrical properties, excellent chemical stability to carbonates and lithium salts, and can also be used plasticizer-free. The global PVDF market was estimated at 51,419.35 tons in 2021 and is expected to register a CAGR of ~21.23% during the forecast period (2022-2027). (@Mordor intelligance report) Whereas the application share for batteries is ~25%. As the global lithium-ion battery market has been steadily, the battery production is expected to grow at a significant rate. The demand for binder and thus PVDF will therefore increase continuously.

The ÖkoMatBatt project funded under the German Federal Ministry of Education and Research is investigating possible alternatives to toxic solvents (N-methyl-pyrrolidone) and fluorinated binder materials in the context of battery cell production. Here, fluorine-free elastomers as well as reactive resins are analyzed and further developed as new binders. These will be investigated in terms of their physical, chemical and electrochemical requirement profile. Within the project, other research topics related to binder substitution will also be explored. These include the structure-property relationship between binder and active material, wetting behavior of the new component, processing of the reactive resins compared to commercial binders using scalable processes, and the life cycle assessment of these substitutes.

In only a few research papers [1-3], as well as in ÖkoMatBatt, possible binder variations, but also binder-solvent variations are investigated as substitutes for fluorinated and toxic materials. Positive results were only achieved with very high binder volumes [4,5]. In other cases, only individual properties of the binders form a benefit compared to PVDF [6, 7] and often fail in adhesion, specific capacity or C-rate stability. In our investigations, it is evident that it is not possible to replace all the properties of PVDF right away, especially if nickel-rich cathodes are involved (such as NMC 811). A step-by-step approach to new materials is the goal here. Furthermore, the process-related properties are also a very important point, which makes a short-term material change from PVDF to an alternative binder system impossible. The simple factor of slurry pH stability, for example, makes a direct implementation into the process very challenging [8]. However, the temperature-side requirements, the drying properties of the new materials, the compatibility with different active materials, as is possible with PVDF, have not been investigated in most cases. However, as we have been able to establish, these are the properties that make a decisive difference to implementation in the industrial process.

Alternative materials certainly have a future in this regard but are still at an early stage of development (TRL 4), as evidenced by most publications, so still require further research to safely establish them in the industrial process.

In addition, a significant time component is required before substitute materials are validated and qualified for each application-specific battery format, as well as in the use of the corresponding application for performance, lifetime and safety. Another issue that has also not yet been clarified for alternative materials is the accessibility and securing of the alternative raw materials that will be used as an alternative to PVDF.

Immediately banning this class of materials would be a major step backwards for efforts to achieve the Green Deal. In addition, global efforts are underway to establish battery recycling and a closed-loop economy of battery production that guarantees the binding and proper disposal of fluorinated components.

For this kind of application of PVDF and related battery materials, a temporary exemption must be created, which allows not only to provide suitable materials, but also to be able to adapt the raw material routes, as well as the processes, when research has developed a new substitute accordingly.

Literature

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