# In-depth Report on the SSB Industry

## Solid-state battery manufacturing process

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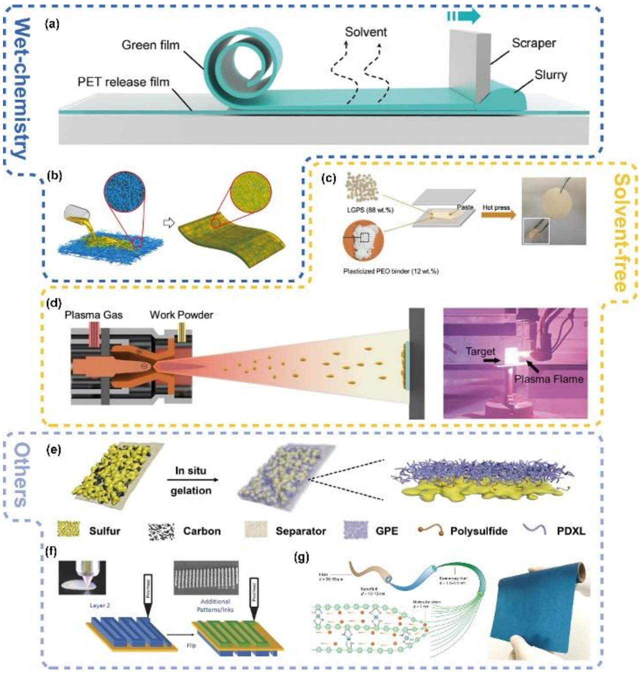
Solid-state batteries use composite positive electrodes, the electrolyte addition method is different from liquid batteries, which is based on stacking. Solid-state batteries and liquid batteries have many similarities in the manufacturing process, such as the manufacturing process of electrode lugs are based on slurry mixing, coating and expansion, slitting is completed after the lug welding, PACK (battery pack processing into groups), the most important difference has three points, 1) solid-state batteries composite cathode material, ie, a mixture of solid-state electrolyte and cathode active material as a composite cathode; 2) electrolyte additive The way is different, the liquid battery is in the pole ear welding after the electrolyte into the battery and encapsulation, while the solid-state electrolyte in addition to the formation of composite anode with the cathode active material, but also need to be in the extension of the completion of the composite cathode and then a coating; 3) liquid lithium-ion battery electrode can be used to roll or stacked piece of the combination of the way, while the solid-state battery due to its solid-state electrolyte such as oxides and sulfides toughness is poor, usually encapsulated in the form of stacked wafers.

The core process of solid-state electrolyte is film formation, which can be divided into dry, wet and other processes. Solid state battery manufacturing, the core process lies in the solid state electrolyte film formation link, electrolyte film formation process will affect the thickness of the electrolyte and related performance, the thickness of the thin, will lead to its mechanical properties are relatively poor, easy to cause breakage and internal short-circuit; the thicker is the increase in internal resistance, and due to the electrolyte itself does not contain the active substance, reducing the energy density of the battery monomer and the system.

**Wet film forming process:** Mould support film, applicable to polymer and composite electrolyte, solid electrolyte solution is poured into the mould, and solid electrolyte film is obtained after solvent evaporation; Anode support film, applicable to inorganic and composite electrolyte film, solid electrolyte solution is poured directly onto the surface of the anode, and solid electrolyte film is formed on the surface of the anode after solvent evaporation; a skeleton supporting film applicable to the composite electrolyte film, wherein the electrolyte solution is injected into the skeleton, and the electrolyte solution is injected into the skeleton, and a solid electrolyte film is formed on the surface of the anode after solvent evaporation. The electrolyte solution is injected into the skeleton, and after the solvent evaporates, a solid electrolyte film with skeleton support is formed, which can improve the mechanical strength of the electrolyte film. The core of the wet process is the selection of the binder and the solvent, which is easy to evaporate and has good solubility and chemical stability with the electrolyte. The disadvantages of the wet process are that the solvent may be toxic, the overall cost is relatively high and the ionic conductivity of the electrolyte may be reduced if the solvent is not completely evaporated.

**Dry film-forming process:** the electrolyte is mixed with the binder, then ground and dispersed, and the dispersed mixture is prepared under pressure (heating) to obtain a solid electrolyte film, which does not use solvents and has no solvent residue. The disadvantage of the dry method is that the electrolyte film is relatively thick and reduces the energy density of the solid-state batteries because it does not contain any active substance.

**Other film forming processes:** These include chemical, physical and electrochemical vapour deposition and vacuum sputtering. These processes are more expensive and are suitable for thin film solid state batteries.

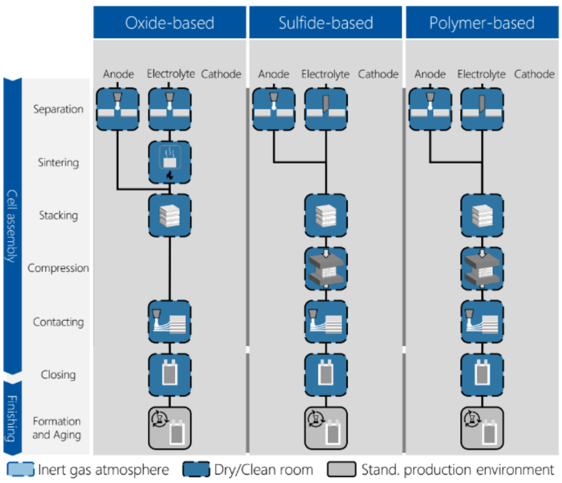


Polymers are compatible with more processes, sulphides have higher environmental requirements, and oxides are suitable for deposition and casting. Solid electrolyte film formation methods, polymers, sulfides and oxides can be combined with their own characteristics to achieve the most suitable film formation process.

1) Polymer solid electrolyte because of its optimal processing performance, has the strongest process compatibility, in addition to the inability to granulate is not suitable for deposition method, the use of dry rolling, dry spraying, extrusion, casting and infiltration processes can achieve polymer solid electrolyte film formation.

2) Sulfides because of poor air stability, not suitable for high temperature extrusion and small size deposition method. ) Sulphides due to poor air stability, not suitable for high temperature extrusion and small size deposition method.

3) Sulphides due to poor air stability, not suitable for high temperature extrusion and small size deposition method, and oxides suitable for deposition and casting. Sulphide is not suitable for high temperature extrusion and small size deposition method due to poor air stability, except for extension, spraying and other processes can be used for sulphide solid electrolyte film formation. 3) Oxide has ceramic properties, high brittleness, must be combined with particle deposition + sintering film formation, or in the solution mixed with the conditions of casting moulding.




Semi-solid batteries can be compatible with the traditional lithium battery production process, the production equipment can be basically compatible with lithium, only need to add a new production line dedicated to the production of semi-solid membrane, production equipment and liquid battery membrane equipment compatible.

Semi-solid batteries require a larger pore size and higher strength of the diaphragm, and use the wet drawing + coating process. Compared to conventional batteries, there is no obvious process change for the diaphragm of semi-solid state batteries and it is sufficient to adjust the parameters. However, as semi-solid state batteries need to improve the ionic conductivity, the diaphragm needs to have a larger aperture and higher strength, and therefore the wet drawing + coating process needs to be adopted. In addition, there is no change in the demand for membranes per unit of semi-solid state battery.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