Formation and mechanical properties of glass fibres

- An invited talk

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Glass fibres are critically important for many modern technologies such as fibre lasers, fibre communications, fibre-reinforced composites, and thermal and acoustic insulation. They are drawn or spun from a glass-forming melt using different fiberizing techniques, e.g., glass preform drawing, extrusion, internal and external centrifugation spinning, as well as continuous fibre drawing from melt bushings. To efficiently produce high quality fibres, it is necessary to understand the fibre formation mechanism, and thereby to optimize glass fibre properties.[1-5] The fibre forming is sensitive not only to the intrinsic parameters of melt (such as liquid fragility, surface tension, liquidus, crystallization temperature) but also to the extrinsic parameters of fiberizing process (such as drawing speed, flow rate, cooling condition, nozzle geometry, nozzle temperature gradient, and melt-nozzle contact surface). The intrinsic parameters are determined by melt chemistry, whereas the extrinsic ones rely on the process design.[6,7]

The forming processes and physical characteristics of glass fibres are more complicated than those of bulk glasses since fibres are often generated under extreme conditions such as high tension, more significant surface creation and hyperquenching. Consequently, fibres possess more open and more anisotropic microstructure, as well as higher potential energy and higher tensile strength, but lower elastic modulus, compared with their bulk counterpart. In this talk, I present our current understanding of the mechanism of glass fibre formation and review some concepts for quantifying the glass fibre forming ability based on glass melt characteristics.[6,7] I describe the impact of the mechanical and thermal histories on physical properties of glass fibres. I give my explanations about the influence of glass composition on mechanical properties, especially elastic modulus, of glass fibres. Based on literature data, I discuss the relationship between elastic modulus and tensile strength of glass fibres for several selected glass compositions.

References

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