Extrusion of optical fiber preform – case of ZBLAN glass.

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Abstract

ZBLAN glass name derives from its components: **Z**rF4, **B**aF2, **L**aF3, **A**lF3, **N**aF. Drawing optical fibers from ZBLAN glass has been of interest, because of the glass's unique properties, such as high transparency in a wide spectrum, low attenuation, low dispersion, and low refractive index. All these parameters make it a great material for multiple applications such as fiber sensors, lasers, lenses fabrication, supercontinuum light source generation, and others.
However, working with ZBLAN glass is challenging. ZBLAN glasses are prone to crystallization during multiple thermal treatments, which worsens the optical properties of the glass. This is due to the small window between the glass transition temperature (Tg) and crystallization temperature (Tc) peak. Moreover, the preparation of preforms by mechanical processing means is problematic due to ZBLAN glass brittleness. Mechanical processing also causes high material loss, which is unwanted taking into consideration the production cost and high-purity raw materials used.

The extrusion process of the ZBLAN glass for the preform preparation can overcome all the problems mentioned above. The general idea of the extrusion is to insert the glass into a steel mouthpiece and put it under pressure applied by a ceramic pushrod. The whole arrangement is placed in the furnace and precisely heated to a temperature a little above Tg and not reaching Tc. Then glass bulk is extruded to the desired shape. As a result, glass fiber preforms in the form of tubes and rods can be obtained, depending on the geometry of the mouthpiece. In the process, almost all the glass is extruded (only a small amount of glass leaves in the steel mouthpiece) allowing to avoid all the issues of grinding and polishing.

The aim of this research was to obtain ZBLAN optical preform with extrusion process and optical fiber assembled by rod-in-tube method from obtained components. The tube was extruded by the process described above; the rod for the core was prepared by grinding and polishing a ZBLAN glass doped with 2% PbF2. The preform was then drawn on the optical fiber tower. The resulting fiber was multimodal, of step-index profile with 200 μm outer and 100 μm core diameter. Analysis of the fiber included scanning electron microscopy (SEM) of fiber cross-section, measurements of fiber losses, and numerical aperture.

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