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Fabrication of High Numerical Aperture Fluoroaluminate Fibres

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A family of fluoroaluminate glasses has been identified as the ideal host for doping with Nd^{3+} for use in the development of lasers and amplifiers in the second telecom window. For optimum performance, a fibre with high numerical aperture (NA), fibre length of 5cm and loss of 10dB/m is required.The high NA implies a core diameter of 3µm is needed and thus the core-to-clad interface represents greater than 50% of the core area. Crystallisation in the interface introduces large scattering losses. The critical step in the fabrication process is preform fabrication. We will present results comparing the different techniques employed and thermal and mechanical fabrication process modelling consistent with our experimental observations and detail the advantages and limiting parameters for the different processes.

Rod-in-tube is the simplest technique of preform fabrication and works exceptionally well for oxide glasses. Fluorides are highly prone to surface crystallisation. We have looked at the fibre losses as functions of polishing material, polishing time, and etching. It is a good first step to test the optical properties and performance in a fibre.

Rotational casting is usually employed in fluoride glasses. The high Tg(450°C) and large expansion coefficient ($>150\times10^{-7}/°K$) of fluoroaluminate glasses creates difficulties in rotational casting. We have modelled the thermal history and the stresses involved in the process. We have prepared glasses of varying expansion coefficients and find that the tolerances for core and clad expansion coefficients should be $<5\times10^{-7}/°K$. We will compare the results of rotational casting with built-in-casting and the influence of processing time, thermal history and mould material (thermal conductivity).

Extrusion as a procedure for preform fabrication is specially suitable for fluoraluminates. Extrusion allows one to operate at temperatures nearer Tg than Tx. Preforms can be prepared with small cores and thus avoid the thermal cycling involved in sleeving to get the singlemode fibre. To date our losses for fibres with 5-8 µm cores vary from 100dB/m using rod-in-tube to 20dB/m using extrusion.