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Application of Low Phonon Energy Glasses for Optical Amplification at 1.3 microns

D. W. Hewak, R.S. Deol, J. Wang, G. Wylangowski,
J.A. Medeiros Neto, B. Samson, M. Naftaly, W.S. Brocklesby,
K.P. Jedrzejewski, R.I. Laming, A. Jha, M. Poulain, M.D. Baro
and D.N. Payne

The search for a practical optical amplifier for the second telecommunications window lead first to Pr^{3+} doped ZBLAN fibres, which currently provide conversion efficiencies of about 3%. These glasses suffer low gains due to the high rate of non-radiative decay from the metastable $^1G_4$ state to the underlying $^3F_4$ level, which dominates over the radiative emission of 1.3 microns to the $^3H_5$ level. Higher gain coefficients can be obtained by increasing the radiative lifetime of the $^1G_4$ level and also through a larger emission cross section for the $^1G_4$ to $^3H_5$ transition, conditions met by many low phonon energy glasses. These glasses all offer a maximum phonon energy lower than that of ZBLAN, ensuring a lower rate of non-radiative decay, and thus the potential for higher quantum yields.

We report here on a series of glasses based on fluorides, chlorides and sulfides whose optical and thermal properties have been characterized and their suitability as a host for a Pr^{3+}-doped 1.3 micron optical amplifier assessed. Losses of these glasses in fibre form have been estimated. Numerical modelling allows comparison of the expected amplifier performance, including the effects of excited state absorption (ESA), ground state absorption (GSA) and amplified spontaneous emission (ASE). Thermal analysis has identified the challenges which remain for the drawing of single mode fibers and the results of preliminary fibre drawing trials are described. From these studies we show that quantum efficiencies over a order of magnitude higher than those demonstrated with Pr^{3+} -doped ZBLAN amplifiers are in principle achieved. The relative merits of each of the various glasses are considered and the challenges before a practical amplifier is achieved are outlined.