Synthesis and growth of materials for solid state lasers

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Since the laser discovery there is a growing effort to develop solid-state media. The classical laser material consists of the active medium - a glass or a bulk crystalline host material - to which is added a dopant. With the advances on laser technology, and miniaturization of many laser devices, the active media in use were reduced to micro dimensions, as fibers or semiconductors epitaxial layers (laser diodes). Recent research showed also the viability of Random lasers, where a highly disordered structure can be used to obtain laser action (emission from powders). It is easy to note that nowadays it is not just choosing the right process for preparation of the laser material that counts, but also making sure that growth can also form the material into the desired shape and at the appropriate length scale.

The neodymium (Nd) laser is the most common type of laser, with a widespread use. In this work we discuss the study on synthesis and growth process of Nd^{3+}-doped $LiYF_4$ (Nd:YLF) and $LiLa(WO_4)_2$ (Nd:LLW), for use as laser media, with different dimensions and shapes (bulk crystals, fiber crystals and nanocrystals). Syntheses were performed by solid state reactions and modified sol-gel method. Bulk and fibre single crystals were prepared respectively, by Czochralski or Zone melting, and micro-pulling-down methods.

Different growth parameters were studied and compared, however, independently of the size or shape, the most important on Nd:YLF growth is the atmosphere control. Moisture contamination can alter the chemical stability and melting behavior of this fluoride. Incongruence may result from residual moisture contamination. In the case of fibers growth this control became more critical because of the capillarity and wetting effects (modification on interfacial tensions) that may forbid stable growth conditions. It is interesting to observe that water adsorption of La_2O_3 from environment was also a problem in the formation of LLW compound and may induce the formation of a secondary phase on the synthesis process. However, Nd:LLW fibers, with good optical properties, can be crystallized as single phase on the growth process under air atmosphere. The first results on the preparation of nanopowder materials will be discussed. Optical characterization and laser action tests of single fibers and nanopowders are under investigation.