NANO HIGHLIGHT

Nanoscale Manufacturing - Nonlinear Nanocomposites for Photonic Devices

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Our goal is to develop manufacturing techniques for nanocomposite materials that combine the functional advantages of their unique properties with the fabrication and direct-write advantages of nanoparticles manufactured in aerosol form. We have shown that it is possible to directly write films and micron-scale lines using supersonic jet deposition of nanoparticle aerosols generated by Laser Ablation of Microparticles (LAM). We are developing new manufacturing techniques that utilize LAM to direct-write fully functional photonic materials.

During the course of this work, the opportunity arose to extend the investigation of nonlinear optical photonic nano-materials to include rare-earth doped nanoparticle composites that can function as optical amplifiers and lasers. We believed that our process could fabricate laser gain materials in the form of nanoparticles and nano-porous films composed of erbium doped glass. The possibility of directly writing nanoparticle waveguide amplifiers and lasers aroused our interest in developing a process for these materials. The supersonic-jet, direct-write process for nanoparticles allows optical gain media to be directly written into waveguides and devices for optical telecommunications. We have now produced Er doped glass nanoparticles with substantially unchanged optical properties but with decreased size and lower sintering temperature to facilitate film formation in the supersonic impaction process.

Er doped glass individual nanoparticles and porous films of nanoparticles were produced as described above for testing. Fluorescence of our Er glass nanoparticles (shown in Fig. 1) is an exact copy of bulk material. Deposited in porous films, these nanoparticles were found to produce bright fluorescence with spectra and lifetimes identical to those of the starting microparticles. No spectral shifts or lifetime shortening was observed for these 20 nm diameter nanoparticles. Individual isolated nanoparticles showed a similar spectrum, but their fluorescence eventually became quenched over a period of months of atmospheric exposure. In conclusion, we have successfully demonstrated that Er doped nanoparticle composites can be produced using our laser ablation and aerosol direct-write process, and that they have optical properties that make them desirable for use in photonic devices such as amplifiers and lasers.

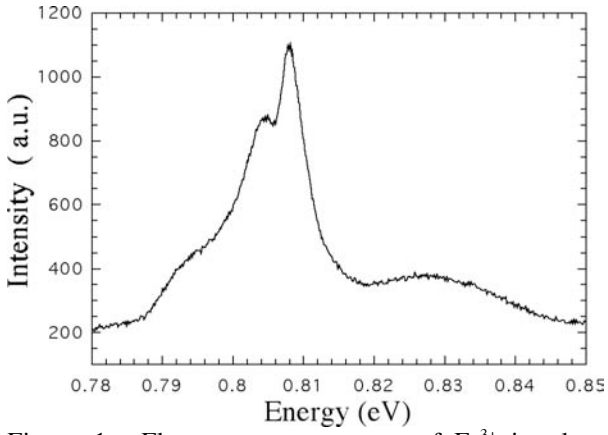

Figure 1. Fluorescence spectrum of Er^{3+} in glass nanoparticle film.

References

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