Er,Yb:ZrO$_2$ / Eu:Y$_2$O$_3$ Core/Shell Assemblies as Potential Temperature Sensors in Explosions

HERGEN EILERS, RAY GUNAWIDJAJA, THANDAR MYINT, Washington State University, APPLIED SCIENCE LABORATORY TEAM — We have recently demonstrated the use of nanophase Eu:Y$_2$O$_3$ and Eu:ZrO$_2$ as temperature sensors in explosions. Initial measurements showed that each of these materials is suitable for a certain temperature range – Eu:Y$_2$O$_3$ covers the range from about 500 K to about 900 K, and Eu:ZrO$_2$ the range from about 800 K to about 1300 K. In order to have one material that can cover a wider range of temperatures, we have prepared core/shell assemblies of these host materials with different dopants. Here we report on the synthesis and characterization of core/shell assemblies consisting of Er,Yb:ZrO$_2$ cores and Eu:Y$_2$O$_3$ shells. The Er,Yb:ZrO$_2$ core was synthesized via forced hydrolysis and the Eu:Y$_2$O$_3$ shell was synthesized via homogeneous precipitation. Subsequently, these assemblies have been heated by a pyroprobe and a CO$_2$ laser for short periods of time. Heat-induced changes in the materials lead to changes in the optical spectra, which can then be correlated with temperature. The Er,Yb:ZrO$_2$ core emits upconverted light in the red and green when excited with 970 nm, while the Eu:Y$_2$O$_3$ shell emits in the red when excited with 532 nm. These spectra can be measured separately allowing us to determine temperatures over a wide range.

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