SAND2019-10037C

Facile Microwave Synthesis and Surface Modification of Rare Earth Oxide Nanospheres for Dispersion in Polymer Matrices

Clare Davis-Wheeler Chin and LaRico J. Treadwell*

A facile new microwave route for the synthesis of small (~ 5 nm), dispersible rare earth oxide nanoparticles (RE_2O_3 NPs; RE = Ce, Er, Gd, Nd, Pr, Sm) has been developed. Rare earth precursor nanospheres with monodispersed size and morphology were produced in high yield via 10 minute microwave (MW) reaction that utilizes low cost, environmentally friendly reagents. Topotactic conversion from the precursor material to the rare earth oxide (RE_2O_3) is performed by heating the as-synthesized precursor material in air. Characterization of both the precursor and RE NPs composition and morphology was conducted via powder X-ray diffraction (PXRD), thermogravimetric analysis (TGA), and transmission electron microscopy (TEM). Results indicate that while heating the precursor induces compositional conversion, the morphology and size of the NPs is unaffected.

Silane surface modification of the RE_2O_3 NPs for optimizing polymer entry was also conducted via facile MW route. RE_2O_3 NPs were functionalized with one of four different silanes in order to examine the effect of silane chain length and substitution on the dispersibility of the modified NPs within different polymer matrices. Surface treatment of the RE_2O_3 NPs with 3-aminopropyltrimethoxysilane (APTMS), triethoxymethylsilane (MTM), triethoxy(octyl)silane (OTEOS), or tetraethoxysilane (TEOS) was performed by refluxing suspensions of RE_2O_3 NPs and each silane under MW irradiation. Confirmation of silane surface modification was carried out via Fourier transform infrared spectroscopy (FTIR) and TGA.

Funding Statement
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.