Magnetic Near-Surface Nanocomposites Formed Using Ion-Beam and Thermal Processing Techniques

Lynn A. Boatner

Solid State Division
Oak Ridge National Laboratory (ORNL), Oak Ridge, TN 37831

Recent investigations at ORNL have shown that "smart" nanocomposite surfaces can be formed on inactive materials through the use of ion implantation and thermal processing to form embedded nanophase precipitates whose properties change at a phase transition or in response to an external perturbation. This approach to forming active near-surface nanocomposites was established by implanting vanadium and oxygen ions, followed by a thermal treatment, in order to create nanophase VO_2 precipitates that are embedded in single-crystal Al_2O_3. The ion-implantation and thermal-processing concept has now been extended to the formation of near-surface nanocomposites consisting of magnetic precipitates embedded in oxides, and it has been used to produce embedded nanophase, faceted particles of Fe, FePt, Fe_3O_4, Co, and Ni in various oxide hosts. The resulting nanocomposite surface exhibits a unique combination of characteristics including a new type of magneto-optical effect via magnetic circular dichroism. In addition to the interesting physical phenomena exhibited by complex surfaces consisting of oriented magnetic nanophase precipitates embedded in a host material, there are numerous opportunities to extend this approach to the formation of a variety of devices (e.g. optical switches, modulators, sensors, etc.) in thin-film, fiber-optic, and integrated-device configurations.