“Smart” and “Active” Nanocomposite Ceramic Surfaces

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Recent investigations at ORNL have shown that “smart” nanocomposite surfaces can be formed on otherwise inactive ceramics through the use of ion implantation and thermal processing to form embedded nanophase precipitates whose properties change either at a phase transition or in response to an external perturbation. The applicability of this approach to forming active near-surface nanocomposites was initially established by implanting vanadium and oxygen ions, followed by a thermal treatment, in order to create nanophaseVO_2 precipitates that were embedded in single-crystal Al_20_3. We have recently extended the ion-implantation and thermal-processing concept to the creation of surface nanocomposites consisting of magnetic precipitates embedded in oxides. Specifically, this approach has been used to produce embedded nanophase faceted particles of Fe, Fe_3O_4, Co, and Ni in various oxide hosts, and 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 active 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.