3.082 - Ceramic Sensors

Fine ceramic materials that include oxides, nitrides, carbides, and silicates are typically synthesized as fine powders and are mainly used in the form of thin films, single crystals, polycrystals and composite materials. They serve diverse and vital functions in the electronics, chemicals, energy, and manufacturing industries.

Positive Temperature Coefficient Resistance (PTCR) ceramic sensors are an important application of these materials, and could provide an attractive 3.082 project. PTCR sensors are resistor materials that undergo a sharp change in resistivity at a designed Curie temperature due to its unique structure and chemical composition. This effect serves important control functions in a wide variety of electronic circuitry and like applications. The PTC resistors are primary donor-doped (La^{3+}, Nd^{3+} or Y^{3+}) solid solutions of barium titanate ceramics of large grain size (typically ~50 microns). Substitution of the trivalent ions produces a barrier layer effect, consisting of semiconducting grains and insulating grain boundaries. Because of the ferroelectric polarization, however, the high resistivity of the grain boundaries is overcome at ordinary temperatures, resulting in the low resistance material. This condition is reversed at the Curie temperature with the loss of the ferroelectric state, resulting in several orders of magnitude rise in the resistivity. It is this unique phenomenon that is made use of in PTCR control circuits such as automatic current limiting, liquid level sensing, and motor start control, etc.

A successful 3.082 project in this area would provide a route to understand, select, design and fabricate ceramic sensors for real-world applications.

Reference Material:

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