THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Superconducting Materials and Properties

MATSCEN 6295

Credit Hours:
2.00 - 2.00

Course Levels:
Graduate (5000-8000 level)

Course Components:
Lecture

Course Description:
Introduction to superconducting materials and phenomena. It will focus on the description of various materials and their properties in terms of basic superconducting phenomena, and the influence of materials-based properties on these phenomena.

Prerequisites and Co-requisites:
Prereq: Grad standing in Material Science & Engineering, Welding, or Engineering; or Math and Physical Sciences; or permission of instructor.

Course Goals / Objectives:
- To understand and be able to perform calculations using critical state models
- To gain familiarity with London Equations, Meissner effect, Type I and Type II superconductivity, fluxons, and, from a phenomenological point of view the energy gap, cooper pairs, coherence length, and the specific heat jump.
- To have familiarity with Ginzburg-Landau equations and the fluxon lattice.
- To develop a working knowledge of materials aspects of NbTi, Nb3Sn, Bi-2212, Bi-2223, MgB2, YBCO, and selected new materials. This includes crystal structure, the phase diagram, processing, and defect structures.
- To develop a working knowledge of flux pinning
- To gain familiarity with processing-properties and structure properties aspects of practical superconducting materials, including the effects of anisotropy, grain boundaries, and processing route on structure and properties.

Course Topics:

- Basic phenomena: Zero resistivity, Meissner effect, critical fields, temperatures, currents.
- London Equations, Magnetization, Type I, Type II, energy gap, penetration depth, coherence length, specific heat
- M-H properties of Type II superconductors, Description of the current carrying state, magnetic penetration states, and fluxons in terms of the GL equations and the fluxon lattice
- Vortex line energy, vortex line interactions, high and low fields. Flux pinning, flux creep, and flux flow. The critical state model. Flux jumps.
- Grains, grain sizes, colonies and structures in YBCO, BSSCO, MgB2, oxipnictides, and low Tc superconductors. Microstructures of wires, films, and bulk samples of superconductors of interest. Coated conductor architecture and fabrication processes.
- Fabrication processes of metal vs oxide Superconductors. Texture in YBCO and BSSCO conductors. Chemical homogeneity and crystalline anisotropy.
- Flux pinning including grain boundary, point, volume pinning, kappa pinning. High Tc superconductors, flux lattice melting, irreversibility fields, new fluxon phase diagram. Collective pinning, flux creep and flux flow in high Tc superconductors.
- Anisotropy in superconductors and its consequences. 2D and 3-D superconductors. The description of various superconductors of interest from this perspective including YBCO, BSSCO, MgB2, oxipnictides, and low Tc superconductors using existing models.
- Electronic Phase Diagrams for YBCO and the Oxipnictides, and Multi-gap superconductors. The competition between magnetic and superconductive ordering, the role of doping, and electronic phase diagrams in materials of interest.

Designation:
Elective