Syllabus of MTSC 6200-011 Imperfections in solids

Lecturer: Dr. Jincheng Du (office Discovery park E-124, Email: du@unt.edu)
Course time: Monday 3:00-5:30 pm; Course location: NTDP D209A

Major reference books:
- Defects in solids (Richard J. Tilley, Wiley)
- The defect chemistry of metal oxides (D. M. Smyth, Oxford University Press)
- Defect and defect processes in nonmetallic solids (W. Hayes and A. M. Stoneham, Dover)

Course description:

Materials properties are usually dominated by the existence of defects of different types and at various concentrations. Characterizing, manipulating, suppressing or exploiting defects consist a crucial part in the discipline of material science and engineering and play a critical role in modern technologies. This course introduces different types of defects and defect processes in materials including ceramics, metal and polymer. Starting with an overview of perfect crystal structures, it will cover fundamental concepts in point defects: Kröger-Vink notation, defect association, defect reaction and Brower’s diagram. Defects in both stoichiometric and non-stoichiometric compounds and electronic defect will be discussed. Effects of defects on electrical conductivity (ionic and electronic), optical properties, and the radiation effects will be given with examples of relevant materials. Extended defects such as dislocations, grain boundaries and surfaces, their relationships to mechanical behaviors, chemical reactivity and catalysis will be also introduced.

Grading:

Midterm (35%)
Final (35%)
Project and term paper (30%)

Syllabus:

Introduction (types of defects, perfect crystal structure)
Point defects (types of point defects, Kröger-Vink notation, equilibrium defect concentration)
Defects in stoichiometric compounds (charge compensation, defect association and reaction)
Defect and diffusion
Ionic conducting materials
Experimental observation of defects
Computer simulation of point defects
Non-stoichiometry (Brower’s diagram)
Electronic properties of point defects
Defect and optical properties
Extended defects (dislocation, grain boundary)
Extended defects (surface and surface properties)