Syllabus of MTSC 6200-011 Imperfections in solids

Instructor: Dr. Jincheng Du (office Discovery park E-124, Email: du@unt.edu)
Course time: Monday/Wednesday 4:00-5:20 pm; **Course location**: NTDP D208B
Major reference books:

- *Defects in solids* (Richard J. Tilley, Wiley)
- *The defect chemistry of metal oxides* (D. M. Smyth, Oxford University Press)
- *Physical Ceramics: Principles for Ceramic Science and Engineering* (Y-M Chiang, D.P. Birnie, W. D Kingery, John Wiley & Sons)

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. Controlling defects also plays a critical role in modern technologies from semiconductor, laser, fuel cell and battery, to super alloys. This course introduces the fundamental concepts of defects and their relationships to different material properties. Starting with an overview of perfect crystal structures, it will cover fundamental concepts in point defects: Krög-Vink notation, defect association, defect reaction and Brower's diagram. Defects in both stoichiometric and non-stoichiometric compounds, 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. In addition, defects in glasses/amorphous materials and in polymeric materials will also be introduced.

Grading:
Homework and class participation (15%)
Midterm exam (30%)
Final exam (30%)
Course project and term paper (25%)

Syllabus:

1. Introduction: effect of defect on properties, types of defects
2. Review of crystal structures
3. Point defects: Krög-Vink notation, equilibrium defect concentration
4. Point defects in stoichiometric compounds: charge compensation, defect association and reaction
5. Point defect and diffusion
6. Ionic conducting materials
7. Non-stoichiometry in oxides: Brower's diagram
8. Electronic properties of point defects
9. Defect and optical properties
10. Extended defects: dislocation and grain boundary
11. Extended defects: surface and surface properties
12. Defects in amorphous and polymeric materials
13. Experimental observation of defects
14. Computer simulation of defects