CME 570: Diffusion Phenomena in Materials (Fall 2019)

Meetings: Mondays 5-7:30 PM, Location TBD

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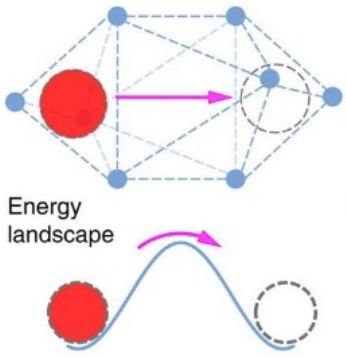
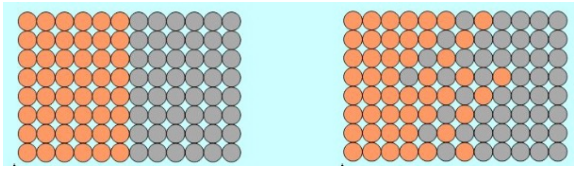
Diffusion is the underlying mechanism for many materials-related processes and microstructure evolution which in turn determine the stability, physical properties, and mechanical performance of materials. To gain a fundamental understanding of kinetics of precipitation, oxidation, creep, and phase transformation it is essential to be acquainted with fundamentals of diffusion. In this course, we review the fundamental theories of diffusion both at the continuum and atomic levels. We learn about mechanisms of diffusion and their intimate interrelation with defects in crystalline solids. Thereafter, we study the application of solid-state diffusion theories to describe different processes including interdiffusion, ion conductivity and precipitate growth.

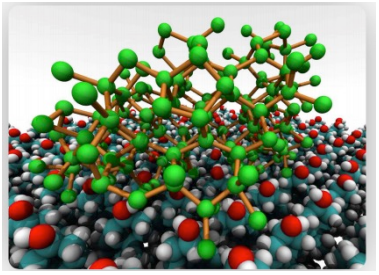
In order to learn how knowledge of diffusion aids us in analysis of materials-related phenomena, we will combine the theoretical tools discussed throughout the course to simulate a real diffusion-controlled process via computational techniques, including i) the state-of-the-art quantum mechanical computer programs called *abinit* to explore the diffusive atomic jumps inside a solid, and ii) a computer programs for kinetic modeling of alloys called *DICTRA* to simulate phase transformation in alloys.

Atomic mechanism of diffusion



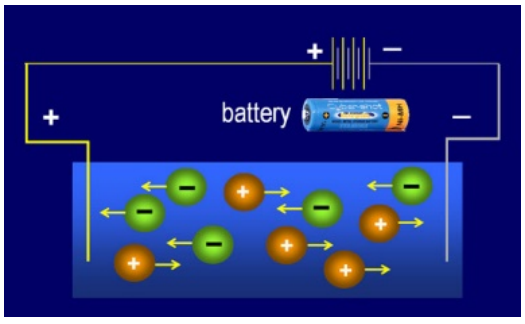
Interdiffusion in a binary system





Heterogenous nucleation rate depends on diffusion

Ionic conductivity depends on diffusivity



Water crystallization via diffusion mechanism