



## NSF Summer Research Program in Solid State Chemistry

# ROCK Camp

University of Oregon

June 15<sup>th</sup> – June 19<sup>th</sup>, 2009



The purpose of ROCK camp is to introduce the concepts, specific skills and experimental techniques specific to solid-state chemistry and materials chemistry, providing hands-on reinforcement of these concepts through lab activities. You will alternately be exposed to the theory behind experimental techniques and then given the opportunity to use them. For example, an introduction to crystal chemistry and x-ray diffraction will be followed by laboratory exercises in both collecting and analyzing x-ray data. Other techniques to be discussed and explored include synthetic techniques, microprobe analysis and surface analytical techniques, electron microscopy and optical, magnetic and electrical properties.

You will each receive a copy of the book, *Reactions and Characterization of Solids* by Sandra E. Dann (Wiley-Interscience, Royal Society of Chemistry, 2002) to take with you. Recommended reading assignments each evening may make the next day's activities more understandable. You will also each receive a packet which includes laboratory procedures for the solid state synthesis of a high-temperature superconductor and the flux synthesis of a phosphor. We ask that you complete the calculations needed for both laboratories by Friday, June 12 and email them to Anae Rosenberg ([anae@uoregon.edu](mailto:anae@uoregon.edu)), to ensure that you will be ready to participate when you arrive. We will meet each morning at **9 am in Room 128 Klamath Hall** for lectures and a preview of the day's activities. After a break for lunch on your own, we will reconvene at 1:30, ending the day around 5 pm. The following provides a brief outline of the schedule.

**SUNDAY JUNE 14: Opening Pizza Party and welcome on Sunday evening, meet in Bean Hall Courtyard at 4:45pm.**

**MONDAY JUNE 15: Synthesis of Solid State Materials**

<i>Time</i>	<i>Place</i>	<i>Topic</i>
9:00 – 10:30	Klamath 128	<b>Lecture – Overview of Synthesis of Solids</b>
10:45 – 11:45	Klamath 128	<b>Lecture – Superconductivity</b>
11:45	<b>Assign groups for laboratory activities; check calculations for superconductor and phosphor syntheses.</b>	
1:30 – 3:30	ISC1 Semiconductor Lab	<b>Lab rotation activities for Day 1</b> <i>Rotation 1</i> – Solid state synthesis of $\text{YBa}_2\text{Cu}_3\text{O}_7$ superconductor <i>Rotation 2</i> – Flux growth of phosphors ( $\text{Y}_2\text{O}_2\text{S}$ doped with Eu, Tb or Sm)
3:30 – 5:00	<b>Free time (Frisbee in Washburne Park)</b>	
6:00	<b>BBQ at Dave Johnson and Cathy Page's house.</b> <i>Meet at 5:45 in Bean Hall courtyard to walk over.</i>	

**TUESDAY, JUNE 16: Crystal Chemistry and X-ray diffraction**

<i>Time</i>	<i>Place</i>	<i>Topic</i>
9:00 – 10:30	Klamath 128	<b>Lecture</b> – Basic Crystal Chemistry and XRD
10:45 – 12:00	Klamath 128	<b>Hands-On:</b> Generating and analyzing X-ray diffraction patterns for simple crystal structures. Bring your calculators!
1:30 – 2:30	ISCI Semiconductor lab	<b>Lab rotation activities for Day 2</b> <i>Rotation 1</i> – Regrind $\text{YBa}_2\text{Cu}_3\text{O}_7$ superconductor, press pellets for final firing <i>Rotation 2</i> – Work up Phosphor by removing flux
2:30 – 5:00	Rotations in Characterization Laboratories (see below).	
5:00	Walk to Ice Cream at Prince Puckler's	

**WEDNESDAY, THURSDAY JUNE 17, 18:**

<i>Time</i>	<i>Place</i>	<i>Topic</i>
9:00 – 12:00	ISC1	<b>AM rotations</b> (see below).
1:30 – 4:00	ISC1	<b>PM rotations.</b>
4:00 – 5:00	ISC1 computers	<b>Hands-On:</b> Introduction to CrystalMaker and Crystal Diffract Software

**FRIDAY JUNE 19: Optical materials and Optical properties**

<i>Time</i>	<i>Place</i>	<i>Topic</i>
9:00 – 11:00	Klamath 128	Optical materials and the interaction of light with matter. Activity – Testing phosphors and superconductors.
11:00	Klamath 128	<b>Tying up loose ends!</b>
Afternoon	<b>Afternoon</b> — Scenic field trip.	

**Tuesday PM, Wednesday and Thursday: Rotations in Characterization Laboratories, ISCI**

	<b>X-ray Diffraction</b>	<b>EMPA</b>	<b>SEM</b>	<b>XPS, SIMS</b>	<b>TEM</b>
Tues PM	Group A	Group B	Group C	Group D	Group E
Wed AM	Group B	Group C	Group D	Group E	Group A
Wed PM	Group C	Group D	Group E	Group A	Group B
Thurs AM	Group D	Group E	Group A	Group B	Group C
Thurs PM	Group E	Group A	Group B	Group C	Group D

Your dorm rooms are available through Friday night. Check out time is noon on Saturday, June 20. You will have access to meals through Saturday morning.

## **Recommended Reading Assignments for ROCK Camp**

From *Reactions and Characterization of Solids* by Sandra E. Dann  
(Wiley-Interscience, Royal Society of Chemistry, 2002)

### **For Day 1:**

Chapter 4: Preparation of Materials in the Solid State

- 4.1 High Temperature Method
- 4.2 Sealed Tubes
- 4.3 Controlled Atmospheres
- 4.4 Hydrothermal Methods
- 4.5 High Pressure
- 4.6 Single Crystals
- 4.7 Nanomaterials
- 4.8 Amorphous Materials
- 4.9 Phase Diagrams and Melt Reactions

Chapter 5: Electronic and Magnetic Behavior of Solids

- 5.2.1 Band Theory
- 5.2.2 Superconductivity

Chapter 7: Selected Topics

- 7.1 Superconductivity

### **For Day 2:**

Chapter 1: Solid State Structure

- 1.1 Types of Solid
- 1.2 Properties of Large Crystals
- 1.3 Crystal Lattices
- 1.4 Unit Cells and Symmetry Elements
- 1.5 Structures Formed by Close Packing of Spheres
- 1.6 Ionic Radius Ratios and Predicting Structure

Chapter 3: Characterization of Solids

- 3.1 X-ray Diffraction

### **For Days 3, 4:**

Chapter 3: Characterization of Solids

- 3.1 X-ray Diffraction
- 3.3 Electron Microscopy