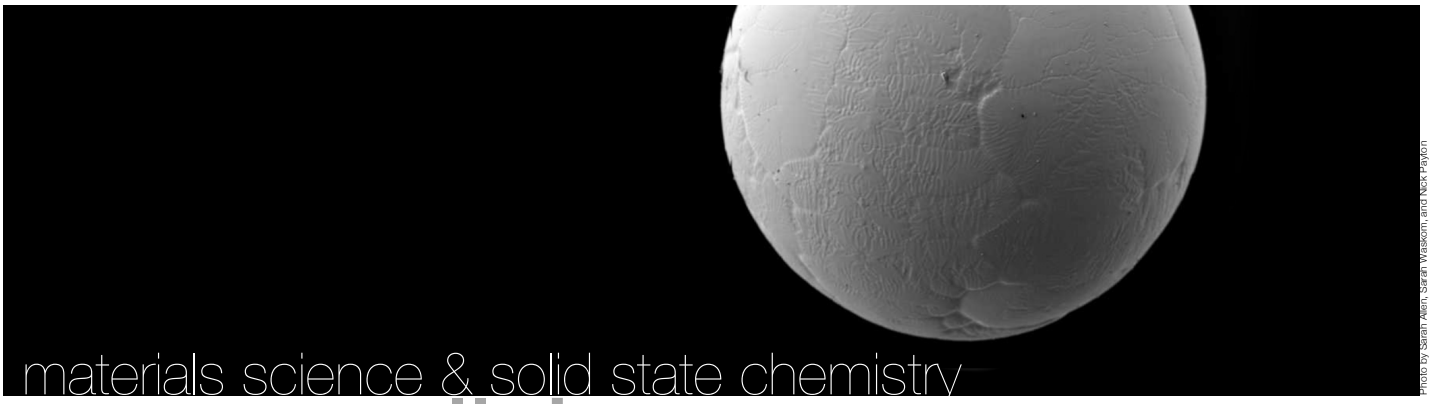

Photo by Sarah Wish, Sarah Watson, and Nick Payton

materials science & solid state chemistry
course syllabus

INSTRUCTOR INFORMATION

Name Jonathan Stolk. **Office** MH365 and AC425. **Office phone** 781-292-2573. **Email** stolk@olin.edu. **Office hours** by appointment – send me email or a meeting request, or catch me in class to set up a time to meet.

COURSE INFORMATION

Meeting Times TW 3:20 – 6:00 pm. **Location** AC413. **Web Site** http://faculty.olin.edu/~jstolk/matsci. **Course Credit** 4 science credits.

COURSE DESCRIPTION

Boring catalog version: This laboratory-based course introduces students to the relationships among structure, processing, properties, and performance of solid-state materials including metals, ceramics, polymers, composites, and semiconductors. Topics include atomic structure and bonding, crystallography, diffusion, defects, equilibrium, solubility, phase transformations, and electrical, thermal, and mechanical properties. Students apply materials science principles in laboratory projects that emphasize experimental design and data analysis, examination of material composition and structure, measurement and modification of material properties, and selection of materials for engineering applications.

Alternative description: Prepare yourselves, as you are about to embark on a semester-long experience in hands-on materials projects that you will create and manage with your teammates. Rather than listening to lectures, you'll choose artifacts and materials systems that you're motivated to explore, and design projects to answer questions that you find interesting. With some of my help in the form of guidelines, assignments, and conversations, you will learn to build connections that help you explain *how* materials behave, *why* they behave that way, and *why* it matters for maximizing technical performance or minimizing negative impacts on our world. This is going to be fun. Yes, indeed!

This offering of materials science formally carries the theme of ***environmental and societal impacts***. What does this mean for you? You'll spend time during each project asking and answering questions related to material impacts on our world. For example, you may examine the life cycle of materials used in common consumer products; explore how raw material extraction and processing affect the health of people or ecological systems; estimate the energy and waste implications of modern materials; investigate how materials may be recycled or reused; or study how our disposal material goods impacts different societies.

TEXTBOOK, ETC.

You have two options. You can purchase or borrow a print or electronic version of Callister's classic introductory materials science textbook, or you can go with Ashby's *Engineering Materials* books, which are available in electronic form for free through Olin's library.

- William D. Callister, Materials Science and Engineering, An Introduction, Wiley. The 6th, 7th, 8th, or 9th editions will work fine.
- Michael F. Ashby and David R. H. Jones, *Engineering Materials 1 – An Introduction to Properties, Applications, and Design, 4th ed.* (Elsevier, 2012), and *Engineering Materials 2 – An Introduction to Microstructures and Processing, 4th ed.* (Elsevier, 2013).

In addition to an intro materials science textbook, you will use a wealth of other resources, including materials handbooks, software, other textbooks, papers, and well-reviewed web resources. If you have trouble finding the information resources you need, please ask me, and I'll happily provide some tips.

LEARNING OBJECTIVES

This course will help you make progress toward the following goals. Olin competency areas are shown in parentheses.

- Build connections between material properties and material structure, bonding, and composition (Qualitative and Quantitative Analysis).
- Explain and predict the effects of processing on material structure and properties (Qualitative and Quantitative Analysis)
- Articulate the important property and performance characteristics of materials used in different applications (Qualitative and Quantitative Analysis).
- Evaluate the societal impacts (e.g., environmental, economic, cultural, political) of materials and materials

systems. (Qualitative and Quantitative Analysis; Contextual Understanding).
- Design, develop, implement, and troubleshoot strategies for the analysis of material systems (Diagnosis).
- Safely and effectively use laboratory techniques to determine material composition and properties; process materials; and examine material microstructures (Diagnosis).
- Work effectively as a member of a project team (Teamwork).
- Use written, oral, and graphical communication to convey methods, results, and conclusions (Communication).
- Demonstrate a capacity for self-directed learning, including goal-setting and selection of learning strategies, time and effort management, personal motivation, resource discovery, and self-reflection and self-assessment (Lifelong Learning).

GRADING

Your grade will only be based on the following six competencies and levels of achievement:

Competency	Percentage of Grade	Level of Achievement
Qualitative Analysis	30	Intermediate
Communication	22	Intermediate
Quantitative Analysis	18	Intermediate
Experimental Design & Diagnosis	10	Beginning
Teamwork	10	Intermediate
Lifelong Learning	10	Intermediate

Each of the competencies will be assessed through the assignments described in the table shown below. These assignments and their corresponding competency areas are described in horrifying detail in the assignment handouts.

Assignments and Competencies	Instructor-Assessed Percentage	Student-Assessed Percentage
Team Projects		
Qualitative Analysis	22	3
Communication	19	3
Quantitative Analysis	15	-
Experimental Design & Diagnosis	10	-
Individual Exams		
Qualitative Analysis	5	-
Quantitative Analysis	3	-
Teaming Evaluations	-	10
Lifelong Learning: Goals and Self-Reflections	-	10
TOTALS (%):	**75**	**25**

I'll provide detailed written feedback in each competency area for the team project deliverables (written reports, presentations, posters, etc.). You will find more details on competency assessments in the project overview documents.

One quarter of the feedback you get in this course is from self-assessments or peer-assessments. You'll complete self-evaluations and peer-evaluations of teaming skills during each project. I'll provide guidelines and survey tools designed to enable teaming assessment and highlight team strengths and problem areas. You'll assess and report on your lifelong learning skill development through goal-setting assignments and written self-reflections. Finally, you will provide other teams with analysis and communication feedback during the project presentations.

HOMEWORK POLICIES

Reading Assignments will be included in most of the homework assignments. The readings are important, as they should help you connect your lab data to materials science concepts, and enable you to make strong arguments supported by materials theory. Sometimes you will need to find your own source material for reading. Please take this task seriously, and please avoid using and citing poor quality web sites.

Problems will be distributed about once a week throughout the first two thirds of the semester. The problems will typically come in two forms: textbook-style problems and open-ended problems. The textbook problems emphasize a particular concept and provide a way to apply the textbook readings. They are typically easy, and I leave it up to you to decide if they provide value to your learning of materials science. I recommend completing as many of these as you need to ensure your conceptual understanding of the materials science theory. The open-ended problems tend to be a bit more challenging, and they often do not have one "right" answer. These problems may require you to do research, make assumptions, synthesize information, and come up with a solution that is supported by solid rationale. I will not collect the homework, but I will rely on you to report difficulties to me. I want to help you work through the trouble spots, but I need to know from you what they are.

EXAMS

Rather than a couple of large exams, I will distribute exam problems throughout the first two thirds of the semester – maybe a total of five or six times. These problems will test your ability to synthesize and apply materials science concepts to your own project work; and they will give me the opportunity to identify trouble spots and provide some feedback.

TIME EXPECTATIONS

This is a 4-credit course, so you should expect to spend an average of 12 hours per week doing everything associated with attainment of the learning goals. Let me know if you're spending much less or a lot more time than this, and we'll figure out how to adjust things.

SUPPLIES

Keeping a lab notebook is good practice, but these days I'd consider it optional for coursework. Most of our equipment

provides digital output, and you might find it more useful to keep electronic records on your computer. Not a problem. Be sure to develop an organizational strategy, and keep track of your team's data and analyses! There's nothing worse that spending hours on an experiment, only to lose your data or realize that you forgot to label your samples.

ATTENDANCE

For a large portion of this course, you are responsible for deciding how you want to spend your time. This is a team-based, project-based experience, so you need to consider the effects your absence may have on your teammates and your project work. You have responsibilities to your team, and you should communicate with them regarding absences. If you are seriously sick, please get well, and please do not come to class. I don't want to pick up what you're putting down. But let me know about your illness via email as soon as possible, and I'll help you figure out how to catch up on things you missed. If you have a different reason for missing class, contact me as early as possible. My hope is that class sessions will be enjoyable and productive for your project team, and that you'll want to hang out in the lab with your peers and me.

FEEDBACK

I use in-class discussions and short surveys as my primary mechanisms for feedback. You don't have to wait for the formal feedback sessions to provide course feedback to me. If something is on your mind, please let me know. Stop by my office, catch me after or during class, or send me an email message. I'm always happy to listen to your comments and consider your suggestions for improvement or modification of the course. I'm also happy to attempt to explain why I do certain things in certain, shall we say, non-traditional ways.

COLLABORATION & THE HONOR CODE

The Honor Code is our friend. Your conduct and work in this course should adhere to the standards of the Olin College Honor Code. I encourage collaboration on homework and project assignments – you can learn a lot from the people who surround you! I may require you to work individually on a few assignments (e.g., exam problems), just to check how everyone's doing with the big concepts. When individual work is required, I will state it explicitly.

You should, of course, always cite your sources. If you are at all uncertain about whether or how to cite a source, or whether a particular kind of collaboration is acceptable, please ask me before you proceed.

LAPTOP USE DURING CLASS

Please bring your laptops to class. You will likely need them for data collection, research, note taking, and information access. Please use your laptops appropriately, and please be cognizant of potential laptop distractions to your classmates and to me. Which is to say, please don't be rude, e.g., by editing your own presentation slides while your peers are trying to present their project results to you. And please don't opt to watch old episodes of Game of Thrones while the rest of your team is working hard to complete the project work. Be nice, be thoughtful.

SCHEDULE

I'll keep a general outline of the schedule for the semester on the web site. This schedule is designed to be somewhat flexible to allow me to make adjustments according to your needs. As necessary, I will post revised schedules and due dates on the course web page.

COURSE APPROACHES

What can you expect from my version of materials science? Please allow me to share my philosophical and practical approaches to learning.

This course is a collaborative endeavor of you students and me, your instructor. We find ourselves, for a variety of reasons, exploring materials science topics in an unconventional educational environment. "Unconventional" in our case means project-based and self-directed learning, with no instructor lectures and tons of responsibility heaped on your shoulders.

Like most Olin courses, *Materials Science and Solid State Chemistry* comprises many things – new concepts, activities, lab time, grades, teams, due dates, procedures, hunger, technical challenges, cast bronze monkeys, project crunch time, and maybe some 90s tunes suitable for project work. But the most important element of this course is you. You are here for a reason, and your reason for being here is critically important to the success of our semester-long experience. Your educational goals, personal ambitions and interests, needs, knowledge, experiences, thoughts and ideas, emotions, and feelings will help shape your time in this course, and you should always feel free to express your thoughts and feelings in this environment. Please be your authentic self in this course.

Another basic aspect of this course experience is that of *interactions*. There are over twenty people in this course, each with his or her own ideas, interests, and feelings. As a result, there will be certainly be times in this course when you feel that the course direction or focus has shifted away from your personal goals, and there will be occasional conflicts of interest, misunderstandings, and miscommunications with others. In these times, we should strive toward a healthy learning environment by confronting the problem while maintaining trust in our colleagues, respect and acceptance of others' ideas and feelings, and empathy for situations that are different from our own.

This course emphasizes student autonomy and the building of self-directed learning skills through hands-on projects. Certain aspects of the course, however, require collaborative decision-making or, on occasion, outright faculty control. To aid the development of a shared and realistic understanding of this learning environment, and to hopefully foster the

greatest creativity, productivity, and attainment of your learning goals, I have outlined what I believe are the responsibilities of the student and instructor in this setting:

Student Responsibilities. Once I provide a general framework for the project objectives and constraints, you will take control of a large portion of this course. You will self-direct your learning in many ways, and depending on the project, you may make decisions related to the motivating context of your learning, the specific knowledge or skill areas to be learned, and the processes by which you learn. You will also reflect on your own goals and learning outcomes, and evaluate the teaming abilities of yourself and your peers. The high levels of student autonomy in this course suggest that you hold an important responsibility for making this course interesting, stimulating, and valuable. If you're not sure why you're here, or if you're only taking matsci because you need the credits, let's try to figure out a way to make it fun, interesting, and useful to you.

You are responsible for unleashing your own sense of inquiry and curiosity – I can't do this for you. You should try to find materials science activities that spark your motivation and resonate with your intrinsic interests, while still aligning with the course constraints. You are responsible for identifying your own learning goals, and for engaging in processes and producing work that aid progress toward these goals. You are responsible for expressing open and honest opinions in the self- and peer-assessment activities, and in providing honest feedback to the instructor. You share the responsibility with the instructor for maintaining constructive and encouraging interactions with others, and for fostering a sense of mutual respect in the classroom. If the course is not working for you, you need to let me know so we can figure out what's up. Of course, if it ***is*** working for you, please share this information, too.

Instructor Responsibilities. As your instructor, I view myself as a facilitator of your learning. I am responsible for establishing and maintaining an environment conducive to student development and attainment of course-related learning goals. I am responsible for clearly identifying aspects of the course that lie under student control, collaborative student-instructor control, and instructor control. I am responsible for defining, or helping students define, project and subject-matter constraints; for making learning resources available or helping students find learning resources; and for identifying laboratory and budget resources and limitations. I'll try to make clear all the choices you have, and the areas in which your choices are limited by the course learning goals or other constraints (e.g., the physical space or safety concerns).

I am responsible for building supportive relationships with students, for facilitating communication among students, for valuing and trusting individuals, and for fostering feelings of mutual respect among all course participants. I am responsible for communicating an honest evaluation of student work, for helping students develop a capacity for self-assessment, and for reporting grades as required by the institution. I am responsible for refraining from applying pressures that unnecessarily stifle creativity or productivity, or that steer students away from relevant learning goals. Finally, I am responsible for maintaining my own interests in materials science topics and in educational research in this course – interests that will certainly shape what we do and how we do it.

In summary, this course will provide an opportunity for you to explore materials science concepts and methodologies, develop your understandings and abilities in many areas, and progress toward your own learning goals in an environment that emphasizes student freedom, curiosity, and personal interests, as well as student responsibility. We're going to have an amazingly fun and productive semester in *Materials Science and Solid State Chemistry*, and I look forward to reflecting on our learning and growth come summertime.