# CHEM 355 Materials Chemistry

**Spring 2023**

**Dr. Deborah Polvani**

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### OFFICE HOURS:

Tuesdays 9:00am – 11:00am

Wednesdays 1:00pm – 3:00pm

Please make an appointment with me whenever you want to see me. I am generally available when not in class or meetings.

**REQUIRED TEXTS / MATERIALS**:

1. Mark T. Weller, *Inorganic Materials Chemistry*. Oxford University Press Inc., New York, 2002. ISBN 0-19-855798-1.
2. David Walton and Phillip Lorimer, *Polymers*. Oxford University Press Inc., New York, 2000. ISBN: 9bogus
3. 780198503897
4. Anthony R. West, *Solid-State Chemistry and its Applications, 2nd ed*. John Wiley & Sons, United Kingdom, 2014. ISBN: 9bogus
5. 781119942948.
6. 3-ring binder is recommended for compiling notes and class handouts.
7. Sakai: Information will be posted here.

I will also use the following sources for some of our class material. These are not required to purchase:

* B.D. Cullity, *Elements of X-Ray Diffraction, 3rd ed*. Prentice Hall Inc., 2001. ISBN: 0-20-161091-4.
* James E. Mark, Harry R. Allcock, Robert West, *Inorganic Polymers.* Prentice Hall, Inc., Englewood Cliffs, NJ, 1992, ISBN: 0-13-465881-7.
* Harry R. Allcock, Frederick W. Lampe, James E. Mark. *Contemporary Polymer Chemistry, 3rd ed.* Pearson Education Inc., Upper Saddle River, NJ, 2003.ISBN: 0-13-065056-0.
* Stanley L. Flegler, John W. Heckman, Karen L. Klomparens, *Electron Microscopy, An Introduction.* Oxford University Press, New York, 1993. ISBN: 0-19-510751-9.
* Ellis, Geselbracht, Johnson, Lisensky, Robinson, *Teaching General Chemistry, A Materials Science Companion.* American Chemical Society, 1993, ISBN: 978-0-8412-2725-5.

**COURSE DESCRIPTION**:

Materials Chemistry will explore many of the fundamental relationships between a material’s chemical structure and the subsequent interesting and useful properties that result. In order for advances in electronic, magnetic, optical, and other niche applications to be made, an understanding of the structure-property relationship in these materials is crucial. This course will emphasize inorganic systems, and topics will include descriptions of various modern inorganic solid-state materials, polymers, and coordination compounds in conjunction with their unique properties; synthesis strategies; current characterization techniques; and discussions about the research and theory that support the application of materials in our world.

**STUDENT LEARNING OUTCOMES**

Students who successfully complete this course should be able to:

* Relate a material’s structure to some of its inherent properties.
* Identify the role that materials play in useful applications in our world.
* Predict logical characterization techniques for various types of materials.
* Manipulate calculations involving powder x-ray diffraction.
* Interpret and present scientific literature or other resources concerning the synthesis, characterization, and/or applications of contemporary materials.

**ASSESSMENT**:

You will be evaluated based upon:

* Five quizzes, in-class or take-home (9% each, total of 45%)
* Project Paper & Presentation (10% each, total of 20%)
* Three assignments (10% each, total of 30%)
* Literature Days (5% total)

Letter grades are assigned from numerical scores according to the chart below. Fractional points are carried to one decimal place until the end of the term when fractional points greater than or equal to .5 will be rounded up and fractional points less than .5 will be rounded down.

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| --- |
| **Grade Chart** |
| 100 - 93 | A | 76 - 73 | C+ |
| 92 - 90 | A- | 72 - 70 | C  |
| 89 - 87 | B+ | 69 - 67 | C- |
| 86 - 83 | B  | 66 - 63 | D+ |
| 82 - 80 | B- | 62 - 60 | D  |
| 79-77 | C+ | 59 - 0 | F |

The quizzes are designed to be completed within 15 – 30 minutes, and will cover topics from the lecture.

You will be required to choose a particular material (within the realm of inorganic solid-state, organometallic/bioinorganic, or polymer topics) and complete a “project” on it. The project includes a short paper describing the material, with particular attention placed on its synthesis, its structure / property relationship, and any niche applications it may have. You should discuss any fundamental chemical reasons for the characteristics the material exhibits. As part of this project, you will also present your topic to the class on final exam day. Various current materials to use as candidates for your project may be provided by the instructor to help you generate ideas. **The Final Exam Day for this class is Thursday, May 11, 2023 9:00am – 12:00pm.**

The graded homework assignments are due at the beginning of class on the designated date.

Please note that grades will be posted to the electronic Sakai website. You will have one week following the return of each quiz or assignment to verify that the score has been posted correctly and to notify your instructor if there is any discrepancy. That same one-week period will be the time to submit any re-grade requests. After this one-week period has elapsed, no further changes can be made to the score.

**ATTENDANCE POLICY:**

Attendance is required for each lecture. If an extenuating circumstance necessitates your absence, you must notify the instructor as soon as possible.

**DISABILITY SUPPORT SERVICES:**

Washington & Jefferson College is committed to providing academic accommodations for students with disabilities. This includes individuals with physical disabilities, learning disabilities, and mental health disorders that meet the definition of a disability under the Americans with Disabilities Act. Students who plan to request accommodations should contact the Director for Academic Success as early as possible, although requests may be made at any time. To determine whether you qualify for accommodations, or if you have questions about services and procedures, please call 724-223-6008 or send an email to dss@washjeff.edu.

**STUDENT COUNSELING SERVICES (SCS):**

As a college student, there may be times when personal stressors interfere with your academic performance and/or negatively impact your daily life. If you or someone you know is experiencing mental health challenges at W&J, please contact Student Health & Counseling at 724-223-6107. The services are free and confidential. In a crisis situation or after hours, contact Campus Safety at 724-223-6032 and ask for the psychologist on-call or call the Washington County Crisis Line at 877-225-3567. Tele-health counseling services are available to all W&J students: those studying remotely, commuters, and students in residence.

**RECORDING OF CLASS LECTURES**

To aid in remote learning, some or all class sessions may be recorded by the instructor of this course for use by current course participants. By appearing in recorded class sessions, you grant consent to such recording and usage; you may opt out by emailing your instructor and requesting to participate via alternate means. Under federal privacy law (FERPA) and Pennsylvania law, recordings may not be made by students or visitors or shared with non-participants without the express consent of all parties whose images, voices, or intellectual work products are contained in the recording. Violations of this policy may result in academic penalties (such as grade reduction or course failure) imposed by the course instructor and/or discipline by the Offices of Academic Affairs and Student Life.

**INFORMATION AND TECHNOLOGY SERVICES (ITS)**

The W&J ITS webpage https://www.washjeff.edu/intranet/information-technology-services/ has a range of helpful resources, including a number of Knowledge Base articles and a page for the HelpDesk, which is located in Technology Center 121. The HelpDesk can be reached at 724-223-6022, or helpdesk@washjeff.edu.

 **CHM 355: Materials Chemistry Spring 2023 Very Tentative Schedule**

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| --- | --- | --- | --- | --- | --- | --- |
| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
| Jan 22 | Jan 23 | Jan 24 | Jan 25**Syllabus & Overview, Intro to Materials Chem.,****Polymers (definitions, MW, types, thermosets, thermoplastics, solubilities, crystallinity)** | Jan 26 | Jan 27**Polymers (history, definitions, MW, types, thermosets, thermoplastics, solubilities, crystallinity)** | Jan 28 |
| Jan 29 | Jan 30 **Polymers (definitions, MW, types, thermosets, thermoplastics, solubilities, crystallinity)** | Jan 31 | Feb 01**Polymer characterization (MW distribution, transitions, IR, NMR)** | Feb 02 | Feb 03**Polymer characterization and processing**  | Feb 04 |
| Feb 05 | Feb 06**Polymer synthesis**  | Feb 07 | Feb 08**QUIZ 1****Polymer synthesis**  | Feb 09 | Feb 10**Properties (Tg, optical, electronic, Uses - bullet proof glass, wiggly for energy, CDs, medical, fibers)****Assign#1 assigned** | Feb 11 |
| Feb 12 | Feb 13**Properties (Tg, optical, electronic, Uses - bullet proof glass, wiggly for energy, CDs, medical, fibers)** | Feb 14 | Feb 15**Properties and Functions, con’t.** **(perhaps food/animal materials)** | Feb 16 | Feb 17**Polymer Literature Day** | Feb 18 |
| Feb 19 | Feb 20**Start on solid-state definitions. (review of crystal types, unit cells, atomic positions, Miller indices)** | Feb 21 | Feb 22**NO CLASS – Symposium on Democracy**  | Feb 23 | Feb 24**Types of crystals (alloys, intermetallics, ionic / molecular / covalent structures) Bonding types (ionic, metallic, van der Waals)** | Feb 25 |
| Feb 26 | Feb 27 **QUIZ 2****Lattice energies, Madelung Constant, charge to radii ratios.**  | Feb 28  | Mar 01**Lattice Energies****Start XRD** | Mar 02 | Mar 03**XRD** | Mar 04 |
| Mar 05 | Mar 06**XRD** | Mar 07 | Mar 08**XRD** | Mar 09 | Mar 10**Electron microscopy, other characterizations**  | Mar 11 |
| Mar 12 | Mar 13**Electron microscopy, other characterizations**  | Mar 14 | Mar 15**QUIZ 3****Synthesis (high temp, low temp, Chemie Douce)** | Mar 16 | Mar 17**Synthesis****Phase diagrams****Assign#1 assigned** | Mar 18 |
| Mar 19 | Mar 20**SPRING** | Mar 21**BREAK** | Mar 22 | Mar 23 | Mar 24 | Mar 25 |
| Mar 26 | Mar 27**Phase diagrams**  | Mar 28 | Mar 29**Properties (electronic – conductors, semiconductors, insulators)** | Mar 30 | Mar 31**QUIZ 4 Assigned (Take-home)****Properties (electronic – band theory, doping)** | Apr 01 |
| Apr 02 | Apr 03**Properties (electronic – thermoelectric, other niche applications)** | Apr 04 | Apr 05**Properties (optical, NLO, lasers, LEDs, fluorescence)**  | Apr 06 | Apr 07**Properties (optical, con’t)****(start magnetic)** | Apr 08 |
| Apr 09 | Apr 10**Properties (magnetic – types, CMR, Superexchange, Curie-Weiss, Neil)** | Apr 11 | Apr 12**Other Phenomena (intermediate/mixed valence, f-block chemistry, negative thermal expansion)** | Apr 13 | Apr 14**Solid-State Materials Literature Day**  | Apr 15 |
| Apr 16 | Apr 17**Coordination Cmpds (definitions, enzymes, Ziegler-Natta, HSAB & strength)** | Apr 18 | Apr 19**Applications of HSAB (geochemical, toxicology, chelation therapy)** | Apr 20 | Apr 21**QUIZ 5 Assigned (Take-Home)****Coordination Cmpds** | Apr 22 |
| Apr 23 | Apr 24**Coordination Cmpds** **Assign#3 assigned** | Apr 25 | Apr 26**Coordination Cmpds**  | Apr 27 | Apr 28**Coordination Cmpds, Misc. Mat.****MOFs (video, questions)** | Apr 29 |
| Apr 30 | May 01**Coordination Cmpds**  | May 02 | May 03**Coordination Cmpds**  | May 04 | May 05**Misc. Mat. Literature Day** | May 06 |
| May 07 | May 08**LAST CLASS****Presentations?** | May 09**All classes End** | May 10**Reading Day** | May 11**Final Exam (Presentations/Paper) 9a-12p** | May 12 | May 13 |

March 29th—Midterm grades due April 4th—last day for withdrawal

***Literature Days: present an article of interest to class.***