Advanced X-ray Scattering

MS&E 803 Section 4 Spring 2015

Instructor: Paul G. Evans, evans@engr.wisc.edu, (608) 265-6773, office: 227 MS&E

Meetings: Monday, Wednesday and Friday 9:55-10:45, MS&E room 235

Office hours: Tuesday 1:30-2:30 PM, MS&E room 227

Homepage: https://ay14-15.moodle.wisc.edu/prod/course/view.php?id=825

Required assignments:

Homework: There will be regular problem sets based on the lectures and reading. (50% of grade)

Mid-term exams: We will have one in-class mid-term exam, scheduled for March 13, 2015. (25%)

Final exam/Report and presentation: We will discuss two options for the end of the course. There will be either a final exam or a project comprising a final paper and presentation on topics chosen by students. Work on these will be done individually or in groups of two. We will also discuss in class the possibility of having these presentations be based on laboratory experiments. (25%)

Resources

Course textbook

J. Als-Nielsen and D. McMorrow, *Elements of Modern X-Ray Physics*, 2nd edition, Wiley, New York (2011) QC481 A47 2011

Further required readings and background materials will be handed out and posted on the course homepage. In addition, the following books will be on reserve in the library.

X-ray optics

D. Attwood, *Soft x-rays and extreme ultravliolet radiation: principles and applications*, Cambridge University Press (2000). QC482 G68 A88 1999

Thin films

P. F. Fewster, *X-ray scattering from semiconductors*, Imperial College Press, London (2000) QC611.6 R3 F49 2000

U. Pietsch, V. Holy, and T. Baumbach, *High-resolution X-ray scattering from thin films to lateral nanostructures*, Springer-Verlag, New York (2004). QC176.84 O7 P54 2004

D. K. Bowen and B. K. Tanner, *High Resolution X-Ray Diffractometry and Topography*, Taylor and Francis, London, (1998) QD945 B683 1998

Spectroscopy

J. Stöhr, *NEXAFS Spectroscopy*, Springer-Verlag (2003).

Books with useful background material

B. E. Warren, *X-ray Diffraction*, Addison-Wesley, Reading, Mass. (1969) QD945 W33 (also Dover Publications, Mineaola, NY 1990).

L. H. Schwartz, *Diffraction from Materials*, Springer-Verlag, Berlin, (1987) QC415 S38 1987

R. W. James *Optical Principles of the Diffraction of X-rays*, Cornell University Press, Ithaca (1965) QC482 D5 J3 1965

A. Guinier, *X-ray diffraction in crystals, imperfect crystal, and amorphous bodies*, Freeman, San Francisco (1963) QD945 G943

Lecture Schedule (Draft 1-21-15)

Week	Meeting Number	Date	Topic
1	1	1/21	Introduction, review of physical concepts, x-ray sources, interactions of x-rays with isolated atoms and molecules
	2	1/23	Optical constants and x-ray reflectivity
2	3	1/28	X-ray reflectivity simulations
	4	1/30	Reflectivity of diffuse or rough interfaces
3	5	2/4	Small angle scattering
	6	2/6	Scaling from dilute to ordered solutions of particles
4	7	2/11	Coherent scattering: x-ray photon correlation spectroscopy
	8	2/13	Kinematic x-ray diffraction
5	9	2/18	Diffraction from nanocrystals: coherent diffraction
	10	2/20	Diffraction from surfaces and interfaces
6	11	2/25	Diffraction from thin films: epitaxy and structural parameters, part 1
	12	2/27	Diffraction from thin films: epitaxy and structural parameters, part 2
7	13	3/4	Superlattice diffraction, quasiperiodic structures
	14	3/6	Diffuse x-ray scattering from defects
8	15	3/11	Coherent diffraction imaging
	16	3/13	**Midterm Exam**
9	17	3/18	Thermal diffuse scattering
	18	3/20	Powder x-ray diffraction: pair distribution function analysis
10		3/25	***Spring Recess: No course meeting***
		3/27	***Spring Recess: No course meeting***
	19	4/1	Dynamical diffraction I
	20	4/3	Dynamical diffraction II
11	21	4/8	Applications of dynamical diffraction in x-ray optics
	22	4/10	X-ray optics for focusing and imaging
12	23	4/15	X-ray spectroscopy: Quantum mechanics, perturbation theory, and selection rules
	24	4/17	X-ray spectroscopy: Analysis using NEXAFS, EXAFS
13	25	4/22	Resonant x-ray scattering
	26	4/24	Magnetic dichroism and magnetic resonant scattering
14	27	4/29	Ultrafast techniques in x-ray scattering and spectroscopy
	28	5/1	Biological, elemental, and magnetic contrast in imaging
15	29	5/6	Phase contrast imaging
	30	5/8	Tomographic methods in imaging and spectroscopy