

Department of Materials Science and Engineering
National Tsing Hua University
Hsinchu, Taiwan

MS622000

Spring 2023

X-ray Microanalysis in Electron Microscopy



Course outline



Wisdom and Compassion

J.G. Duh

I. Course Description

1. The purpose of this course is designed to familiarize the student with the operation of EPMA, and SEM-EDX, Focuses are directed to study the effects of instrument operational parameters on X-ray microanalysis, in addition to the strategy and skillful technique for SEM and FESEM image. Related techniques, including EDX, and WDX will be addressed.
2. Another aim is to familiarize the student with the principle and application of electron microanalysis via X-ray technique.
3. Special efforts will be focused on the newly developed field emission electron probe micro analyzer, and liquid nitrogen-free EDX .



Text books

1. J.I. Goldstein, D.E. Newbury, J.R. Michael, N.W.M. Ritchie, J.H.J. Scott, and D.C. Joy., “Scanning Electron Microscopy and X-ray Microanalysis”, 4th Edition, Springer.(2018)
2. R.E. Lee, “Scanning Electron Microscopy and X-ray Microanalysis”, PTR Prentice Hall. Inc. (1993).
3. Class notes and related materials are also posted in iLMS platform <http://lms.nthu.edu.tw/course/index.php>.



References

1. J.I. Goldstein et al., “Scanning Electron Microscopy and X-ray Microanalysis”, 3rd Edition, Plenum Press (2003).
2. J.I. Goldstein, et al., “scanning Electron Microscopy and X-ray Microanalysis,” 2nd edition, plenum press, (1992).
3. Newbury et al., “Advanced Scanning Electron Microscopy and X-ray Microanalysis,” Plenum Press, (1986).
4. J.I. Goldstein, et al., “Scanning Electron Microscopy and X-ray Microanalysis,” Plenum Press, (1981).



5. V.D. Scott and G. Love, “Quantitative Electron-Probe Microanalysis,” Ellis Horwood Limited, 1983
6. J.A. Chandler, “X-ray Microanalysis in the Electron Microscope,” North-Holland Publishing Company, 3rd printing, 1981
7. “Electron Probe Quantitation,” Ed. K.F.J. Heinrich and D.E. Newbury, Plenum Press, 1991
8. D. Brandon and W.D. Kaplan, “Microstructural Characterization of Materials,” John Wiley & Sons, 1999
9. P.E.J. Flewitt and R.K. Wild, “Physical Methods for Materials Characterization,” 2nd Ed. Institute of Physics Publishing, 2003
10. 杜正恭 “電子束X光微區分析,” Chap7. in材料分析, Materials Analysis, P.161-183, 汪建民主編, 中國材料科學學會出版, 2014
11. 杜正恭、羅中倫、蔡淑月, “EPMA, SEM/EDS在材料分析與鑑定的應用”, P.9-17, 材料會訊, 第七卷第3期, 中國材料科學學會出版, 2000.7
12. 杜正恭、王凱正、蔡淑月, “電子微探儀 Electron Probe Microanalyzer”, P.69-76, 科儀新知, 第三十卷, 第六期, 2009



IV. Course outline

1. Introduction
2. Historical perspective
3. X-ray Generation
4. Beam-specimen interaction
5. Measurement of X-ray spectra
6. Wavelength-dispersive spectrometry
7. Energy-dispersive spectrometry
8. Qualitative analysis
9. Quantitative analysis
10. Evaluation of ZAF methods



- 11. Experimental determination of X-ray intensity**
 - Specimen preparation**
 - Selection of standards**
 - Operation condition**
- 12. Statistics, precision and detection sensitivity**
- 13. New design of nitrogen-free EDX detector**
- 14. Special topics:**
 - Light element detection**
 - Trace element detection**
 - Particle and rough surface microanalysis**
 - Thin film microanalysis**
- 15. Advanced analytical techniques in electron microanalysis and recent developments.**



V. Teaching style

1. Majority of the class materials will be posted in the website iLMS
2. Most course materials will be delivered with the aid of PowerPoint.
3. Lab demonstrations will be specially designed for practical purpose.

VI. Grading

1. Homework: 20%
2. Midterm exam: 35%
3. Lab demo and class performance: 10%
4. Term project: 35%
 - 1) Oral presentation (20%)
 - 2) Written report (15%)



VII. Lecturer

Prof. J. G. Duh

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VIII. Instructor's comments

1. The lecture contents will not exactly follow the text. More materials will be distributed to students at appropriate time on the website.
2. Brief and precise description of the fundamental principle and critical technique for related analytical tool will be addressed.
3. Lab demonstrations will be set-up during the normal class time of specific day when available. Each student should submit a brief report after the demon.
4. A group of students will be assigned a specific topics in microanalysis related field. Each group should give an oral presentation in the last month of this semester. In addition, a written report should be submitted by the end of the semester.
5. Criterion, rules and regulations for the oral presentation and written report will be announced later in the class.



IX. Special Remarks:

1. Homework should be submitted right before the class on the due day. No late homework can be accepted.
2. No food or drink is allowed in class. (Water is OK.)
3. The cellular phone should be turned off in class. Violator will be asked to leave the classroom. (If you have something very important and should take the phone call, have it in the vibration mode. No sound of ring can be heard)
4. Be in time to sit in the classroom. It is impolite to walk into the class late.



X. Class Hour:

Monday 09:10~11:50



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