ELEC-E8711 Materials Compatibility (5 cr)

Teaching Periods: III-V

Lectures Tuesday 08.30-10.00 at Pieni-Sali, Micronova, Tietotie 3

Workload: Lectures 20 h + Assignments (group and independent work) 110h

Learning Outcomes: The main focus of the course is placed on understanding the materials compatibility in heterogeneous structures utilized in smart system integration and ubiquitous electronics. After the course the student can utilize a method combining thermodynamics and reaction kinetics of materials, theories of microstructures, mechanics of materials as well as mechanisms of adhesion to solve materials compatibility issues in electronics and microsystems. The student understands the thermal, thermomechanical and mechanical properties of materials used in electronic products from reliability point of view and how these properties can be controlled. In addition, the principles of finite element modelling will be comprehended.

Content: The basics of materials compatibility, chemical reactions between materials, interfacial phenomena and their effect on the material properties. The interpretation of phase diagrams, diffusion mechanisms and microstructures of real cases from microsystems integration. The mechanical, thermal and thermomechanical characterization of microsystems. Modelling tools, principles of reliability mechanics and materials behavior under different stresses. A brief training of finite element software (Abaqus) about thermomechanical simulation.

Assessment Methods: Three assignments (100%).

Study Material:

- Laurila, T., Vuorinen, V., Paulasto-Kröckel, M., Turunen, M., Mattila, T.T., Kivilahti, J., Interfacial Compatibility in Microelectronics
- Paul, A., Laurila, T., Vuorinen, V., Divinski, S.V., Thermodynamics, Diffusion and the Kirkendall Effect in Solids, Chapters 1-5

Substitutes for Courses: S-113.3102 Materials' Compatibility I and S-113.3103 Materials' Compatibility II

Prerequisites: ELEC-D8710 Principles of materials science and ELEC-E8712 Design for reliability are recommended

Tentative schedule:

Week/date	Content
Week 2/ Tuesday 10.1.2017	General presentation of the course and the ”Big picture”, VV&MPK
Week 3/ Tuesday 17.1.2017	Recap: Binary phase diagrams and G-xi diagrams, Ternary phase diagrams I
Week 4/ Tuesday 24.1.2017	Ternary phase diagrams II, VV 1st assignment instructions, Part A
Week 5/ Tuesday 31.1.2017	Ternary phase diagrams III, HD 1st assignment instructions, Part B
Week 6/ Tuesday 7.2.2017	Principles of Diffusion, Diffusion calculations, VV
Week 7/ Tuesday 14.2.2017	Diffusion couples and TDK method, VV
Week 8/	Individual working on 1st assignment
Week 9/	Individual working on 1st assignment

Week/date	Content
Week 10/ Tuesday 7.3.2017	Recap: The mechanical properties of the materials, stress state. Plastic deformation in metals and polymer. The formation of thermomechanical stresses, fracture and fatigue. VV First assignment DL
Week 11/ Tuesday 14.3.2017	Mechanical properties of nanomaterials and –structures MB Instructions 2nd assignment -Infineon case. VV
Week 12/	Individual working on 2nd assignment
Week 13/	Individual working on 2nd assignment
Week 14/ Tuesday 4.4.2017	FEM introduction. Mechanical and thermomechanical modelling. Modelling methodology: Goals for the simulation, building up the model, material models, computing and analysing the results. JL 2nd assignment DL
Week 15/ Tuesday 11.4.2017 Maarintalo, Maari B 08.30-12.00 o'clock	FEM demo JL; 3rd assignment (FEM) instructions
Week 16/ Tuesday 18.4.2017 Maarintalo, Maari B 08.30-12.00 o'clock	FEM working in groups;
Week 17/ Tuesday 25.4.2017 Maarintalo, Maari B 08.30-12.00 o'clock	FEM working in groups;
Week 18/ Tuesday 2.5.2017	No lecture
Week 19/ Tuesday 9.5.2017	3rd assignment (FEM) presentations. JL Course summary and feedback VV