UNIVERSITY OF CHEMICAL TECHNOLOGY AND METALLURGY
FACULTY OF METALLURGY AND MATERIALS SCIENCE
CENTRE OF MATERIALS SCIENCE

Confirmed by:
Dean:
/Assoc. Prof. PhD eng. I. Gruev/

EDUCATIONAL PROGRAM

Discipline (Optional, Group A): "Semiconductor materials"
Subject: "Materials Science"
Educational degree: Magister

Prepared by:

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Centre of Materials Science

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S O F I A, 2006

EDUCATIONAL PROGRAM
For the discipline "Semiconductor materials"

1. Number of lessons within the educational program

1 No	Educational type	Семестър	Number of lessons		
			Weekly	Total	1
1.	Lectures	III		20	
2.	Exercises	III		20	
1 3.	Form of control	Exam.			

II. Annotation

The discipline is planned for introduction to students from the specialty "Materials science" studying for their M.A. degrees. They will be introduced to a major group of materials - the semiconductors - which have a decisive share in contemporary scientific and technological developments. The course includes basic knowledge which will help students understand the physical processes in semiconductors and their specifics, differing from those of metals and dielectrics. The specific physical chemistry of semiconductors which is expressed in a crystal structure, defects and nature of the chemical connection are all expressed with the help of basic notions, acquired during the general education courses. From the point of view of the fundaments and the technological aspects, the processes have been discussed in their relation to the synthesis, the purification and the growth of mono crystals made of semiconductor materials. The accent has been placed on the most popular semiconductors: germanium, silica, A^mB^v and A^nB^{vl}. Their features have been presented as well as their application and industrial production with a high degree if purity and perfection of the resulting crystals.

Polymers with semiconducting properties, i.e. polymers with spatially extended π-bonding system, offer unique physical properties, unobtainable for conventional polymers. In these lectures the basis of chemistry and physics, as well as potential technological applications of those polymers will be considered.

In their neutral (undoped) form the conjugated polymers are semiconductors and can be used as active components of „plastics electronics" such as polymer light-emitting diodes, polymer lasers, photovoltaic cells, field-effect transistors, etc.

Doped conducting polymer are presented, as well as their use as conductive plastics, optical pH-sensors, gas separation membranes, etc.

III. LECTURE COURSES

1. Definition for semiconductors (SC). Zone theory of the electrons in solid materials. General principles. Classification of the materials from the point of view of the zone theory. Inherent and added SC-s. Basic and supplementary charge carriers. Compensated semiconductors. 2 hours

2. Balanced concentrations of charge carriers. Concentration of SC. Concentration of charge carriers in mixed SC. Degenerate SC. Thermal dependency of the concentration of the charge carriers. Mechanisms for diffusion and mobility of the charge carriers in SC. Dependence of specific conductivity of semiconductors on the temperature, the admixes and the electricity field in SC.

2 hours

3. Unbalanced charge carriers and mechanisms for re-combinations. Optic and photoelectric occurrences in semiconductors. Thermoelectric and magnet-electric occurrences in SC.2 hours

4. Theoretic introduction to P-N transitions. Characteristics of P-N transitions. Types of P-N transitions. VACh of a P-N transition. Diode structures (planar-epitaxial and diffusion). 2 hours

5. Basic methods of synthesis of semiconductor compounds. Direct methods (single and double-temperature). Indirect methods for producing binary halogenates Specifics. 2 hours

6. Germanium and silica. Production and basic chemical compounds; properties and application. 2 hours

7. Compounds AΈ' and A~B\ Production, basic chemical compounds, properties and application. 2 hours

8. Growth of mono-crystals according to the "Chohralski" method. Technological and constructive bases. Mono-crystal growth from silica via zonal smelting. Technological requirements. Construction bases. 2 hours

9. Inherenly conducting polymers. Historical development. Synthesis, processibility and environmental stability of the main representatives of conjugated polymers: polyacetylene, poly-pyrrole, polythiophene and its derivatives, poly (p-phenylene viniylene) and its derivatives, polyaniline in different oxidation states. 2 hours

10. Conjugated polymers as semiconductors. Basic characteristics. 1 hour

11. Doping of conjugated polymers. Principles and methods. 1 hour

12. Application of undoped conjudated polymers (polymer light-emitting diodes, polymer based lasers, photovoltaic cells, field-effect transistors, etc.). 1 hour

13. Application of doped conjudated polymers (conductive plastics, optical pH-sensors, heterogeneous catalysts, gas separation membranes, etc.) 1 hour

IV. EXERCISES

1. Producing mono-crystals from InSb after the Chohraslski method. Defining the type of conductivity and measuring of specific conductivity. 3 hours

2. Synthesis of poli-crystal cadmium sulfite. 3 hours

2. Direct single-temperature synthesis of crystal and glass-formed semiconductors. 4 hours

V. **REFERENCES**

1. Bardaley W.. Hurde D., Mullin J., Crystal Growth: A Tuterial Apreach, North Holland Pub. Corp., 1979.

2. Pamplin B.. Crystal Growth, II Ed. Pergamon Press, 1980.

3.Lev I. Bergere, Semiconductor Materials, CRC (December 13, 1996)

4. Dieter K. Schroder. Semiconductor Material and Device Characterization. Wiley-IEEE Press; 3 edition (January 30. 2006)

5. Handbook of Organic Conductive Molecules and Polymers (Nalwa HS. ed.) Wiley, Chichester, 1997

Polymeric and Organic Electronic Materials and Applications, MRS Bulletin. 22 (6), 1997