

## REVIEW OF THE LECTURES OF MATERIALS - SECTION "A"

### 1. GENERAL REMARKS

188 summaries were selected for this section of the symposium. It is, thus, understandable that in the range of time given, it was not possible to prepare a real survey, but only a short recording of main topics investigated and of the purposes aimed. To obtain a better overview on the content of this section of the symposium, the summaries were classified in 16 groups on the base of the content, as it could be understood from the summary. In most of the summaries the accent is given to the goal and the method of investigation and little information is given on the achieved results. It is, thus, possible that a number of summaries were not placed in the suited group.

A wide range of topics is presented: the formation of microstructure by solidification, hot working, and heat treatment, equilibrium and kinetics of phase formation, tensile properties from cryo over ambient to very high temperature, fatigue strength by stressing and combined stressing and fretting, creep rate at elevated and very high temperature, calculation of phase equilibria and kinetics, new and improved methods for the characterization, improvement of technology, development of new alloys, modelling of properties and processes, and calculation of stresses by operation and of lifetime of parts of machines and structures. In a number of summaries remarkable achievements, theoretical and for application, are presented. In this aspect, the average quality and relevance for application of the achievements reported, although only in summaries, are improved in comparison to the previous symposium.

In the majority of summaries the alloy investigated are different steels. In a number of summaries also results on investigations on aluminium, titanium, magnesium, nickel, zirconium, niobium, molybdenum, copper and heavy metals alloys are reported. In most of the groups, the exception is only the group "Aluminium and magnesium" alloys, investigations on alloys with different base metal are included.

In comparison to the previous symposium, the number of summaries reporting on investigations on amorphous and nano grain size alloys and summaries with theoretical calculations of equilibria and properties as well as modelling are increased. Of equal importance is the considerable number of summaries on calculation of the stressing of parts in use and of degradation of properties due to surface oxydation or microstructural processes at the temperature of operation f.i. steels in parts of thermal power works.

The summaries were submitted mainly scientists from universities and institutes. Authors from industrial companies are found in 22 summaries, mostly in those submitted from Slovenian scientists.

The number of authors of summaries is in the range one to seven, mostly two or three.

The countries of origins of authors are: Croatia, Ukraine, Russia, Bela Rus, Litva, Polonia, Slovakia, Czech Republik, Slovenia, Romania, Turkey, Spain and Bosnia-Herzegovina. Authors from different countries are found in a small number of summaries, also.

### 2. GROUPS AND TOPICS OF SUMMARIES

#### 1. Processing of ferrous and non ferrous alloys (contributions no. 1 - 20).

*Topics:* thermodynamic analysis of solidification and malleablising, principles of development of alloys for different purposes, formation of cracks on internal defects, effect of processing parameters on mechanical properties, thermomechanical processing, horizontal continuous casting, effect of processing parameters on properties, cause and formation of surface defects, reprocessing of wastes.

#### 2. Powder metallurgy (contributions no. 21 - 25).

*Topics:* manufacturing and properties of alloys, compressibility of powders, failure of powders products.

**3. Physical metallurgy** (contributions no. 26 - 49).

*Topics:* mechanism of plastic deformation, microstructure, properties and fracture; constitutive equations on strain hardening, nucleation of thermal cracks, structure and properties of semiconductive silicon, thermodynamic analysis of solidification and solid phase processes, bake hardening effects, secondary grain growth and texture of non oriented steel sheets, phase transformation and strengthening, numerical calculation of solid state transformations, hot deformability and recrystallisation.

**4. Mechanical properties** (contributions no. 50 - 73).

*Topics:* tensile properties at room, low and very high temperature, creep rate of alloys and welds, effect of plastic pre-strain, effects of alloying, correlation tensile properties and hardness, impact strength and fracture, properties by submicro grain size, formability, fretting fatigue.

**5. Wet and dry corrosion, corrosion resistance** (contributions no. 74 - 83).

*Topics:* temperature and oxydation resisting coatings, atmospheric corrosion, surface oxydation, corrosion on chlorine and sulphur atmosphere, analysis of corrosion layers.

**6. Surface technology** (contributions no. 84 - 88).

*Topics:* plasma and silicide coating layers, laser surface modification

**7. Computer calculation and modelling** (contributions no. 89 - 102).

*Topics:* creep modelling, stress calculation in parts in use, calculation of deformation temperature, modelling of stress concentration, effect of combined stresses, effect of cyclic stressing, current induced stresses, prediction of properties.

**8. Composites** (contributions no. 103 - 112).

*Topics:* microlayer composite, hardness at elevated temperature, fibre reinforced composite, layered composite for electric contacts, effect of temperature on properties, manufacturing by precipitation and internal oxydation.

**9. Methodology of investigation** (contributions no. 113 - 131).

*Topics:* visualisation of fatigue cracks, determination of stresses in parts in operation, electrodynamic excitation in fatigue tests, tensor approach for residual life assessment, stress intensity factor, digital image processing, fractal analysis, combining of tensile tests and acoustic emission, mapping structure analysis.

**10. Aluminium and magnesium alloys** (contributions no. 132 - 138).

*Topics:* boron alloys modification, phase's composition in AlSiMg alloys, structure of liquid AlSi alloy, effect of Ce and Y on microstructure, properties of MgCeY alloys, phases in AlCrSc alloys, solid solution in AlMgMn alloys v with Zr and Sc, thermal analysis of AlCu<sub>4</sub> alloy.

**11. Non ferrous alloys** (contributions no. 139 - 149).

*Topics:* energy dissipative capacity of titanium alloys, microinhomogeneity and cyclic loading of titanium alloys and welds, viscoelastic properties of titanium alloys, thermal analysis of solid titanium alloys, TiNiNb shape memory alloys, surface oxydation of Zr alloys, alloys for fusible elements, hardening of Ti alloys, lead free solder alloys.

**12. Welding, microstructure and properties of welds** (contributions no. 150 - 155).

*Topics:* fatigue limit and residual stresses, fusion welding repair of rotor blades, fractographical examinations of aluminum alloys welds, fatigue strength of coarse grained layer of structural steel weld, fracture toughness and hot cracking of aluminum alloy welds.

**13. Nano and amorphous alloys** (contributions no. 156 - 165).

*Topics:* nanostructure in the liquid Al-Si alloy, computer simulation of phase transition in a nanoalloy, structure of nanograins in Ni and Al alloys, magnetic properties of a complex amorphous and nano alloy, nanoalloys obtained by quenching, surface area of nanopowders, nano shape memory alloys, amorphous alloys produced by water atomisation and melt spinning, nano AlNiRe alloys.

**14. Application and degradation in service** (contributions no. 166 - 174).

*Topics:* microstructure modification of steel in service at elevated temperature, residual life assesment and calculation,

degradation of microstructure and properties by operation, casting dies failure, use of stainless steels for vessels for acid.

**15. Miscellaneous** (contributions no. 175 - 186).

*Topics:* nuclear magnetic resonance spectra, relation strength - metal economy, explosive cladding technology, strain hardening prediction, structure and properties of high-chromium irons, optimum microalloying, glasses forming, properties and crystallization, heat treatment of steel forgings, melable cast alloy, steel seamless tubes, optimal metallurgical parameters for bend, chemical composition influence

**16. Non metallic's** (contributions no. 187 - 188).

*Topics:*  $\text{TiO}_2\text{-P}_2\text{O}_5$  glasses formation and properties, testing of glass viscosity.

**3. SELECTED SUMMARIES**

1. J. Zrník, I. Mamuzić, P. Lukaš, O. Muransky, P. Jenčuš, Z. Novy: Design of thermo mechanical processing and transformation behaviour of bulk SiMn TRIP steels.  
In situ laboratory investigation of the austenite to ferrite transformation at different temperature with neutron diffraction aimed to the the explanation of transformation induced plasticity.
2. F. Tehovnik, B. Arh, B. Arzenšek, D. Kmetič, S. Jakelj: Hot processing of duplex stainless steel.  
With laboratory rolling tests in temperature range 1250 to 850 °C the condition for industrial rolling of plates of duplex 50/50 austenite ferrite duplex steel were investigated. Greater deformability was found for the temperature range 950 to 1100 °C.
3. N. K. Kucher: Refining of constitutive equations of strain hardening theory for non- isothermal deformation processes. The parameters of constitutive equations are postulated in dependence on strain, temperature and loading history, including the creep rate and the accumulated damage. The procedure is checked with calculations of creep rate for steel and an aluminium alloy.
4. V. V. Buchanovskii, I. Mamuzić: Low cycle strength and cyclic creep of a molybdenum-tungsten alloy at high temperature.  
The properties were investigated in temperature range 1770 to 2270 K. A unified dependence was obtained between the cyclic steady state creep rate and the ratio of equivalent stress to the yield strength.
5. E. V. Najdenkin, S. V. Dobatkin, P. D. Odessky, Yu. R. Kolob, G. I. Raab: Mechanical properties of submicrocrystalline 0,1 CMnVTi steel at elevated temperature.  
After ECA (equal channel angular) pressing the properties were determined in temperature range 20 to 500 °C. The yield stress is greater for the ECA deformed steel up to the temperature of 600 °C.
6. A. Hernas, B. Dytkowicz, M. Imosa: High temperature corrosion resistance of some metallic materials.  
Different heat resisting steels and alloys were submitted to surface reaction in an atmosphere containing oxygen, hydrochloride and sulphur dioxide, typical for waste combustion in boilers for up to 1200 hrs. in temperature range 500 to 800 °C.
7. T. Yu Yakovleva: State evolution model for metallic materials under cyclic loading.  
A physical model based on the formation of local deformation regions was developed valid for incubation and fatigue fracture growth. The fatigue curve and the kinetics of crack formation and growth from short to long cracks are derived.
8. N. I. Grechanyuk, I. Mamuzić, V. V. Buchanovskii: Production technology and service characteristics of microlayer composite materials for electric contacts of new generation.  
The manufacturing of microlayer composite materials for contacts consisting of copper, zirconium, itrium and molybdenum with electron beam evaporation and layer condensation from the vapor phase is described. The mechanical properties of contacts were determined for the range of temperature 270 to 1070 K.
9. M. Godec, B. Šuštaršič, M. Jenko: High magnification ABSD mapping analysis of FeSiB powder particles.  
Nanocrystalline particles were analyzed with electron back scatter diffraction (EBSD) and their transformation to a nanocrystalline structure was investigated.

10. V. I. Mazur: Influence of heat treatment on the nano structure of liquid Al-10.6 Si alloy.  
The structure of the liquid alloy was investigated and the interatomic interaction determined. It was found that crumbly packed Al-Si clusters appear above 780 °C with a metastable tetragonal  $\eta$ -phase arrangement of atoms.
11. N. R. Bochvar, N. P. Leonova, E.I. Lysova, L. L. Rokhlin: Investigation of phase composition and mechanical properties of AlMg alloys with Ce and Y.  
On the base of investigations with optical, scanning microscopy and x ray diffraction part of the Al rich corner of the section of AlMgCe and AlMgY phase diagrams at 430 and 275 °C were constructed. Also the mechanical properties of the alloys were determined.
12. I. Yu. Khmelevskaya, V. Ya Abranov, N.M. Aleksandrova, D. V Borobkov, S. Yu. Makushev, N. A. Polyakova, N. N. Popov: TiNiNb(Zr): Shape memory alloys with wide martensitic hysteresis.  
A dynamically polygonised substructure improving the functional properties of alloys was developed with thermomechanical treatment. Doping with Zr produced an improvement of functional properties and a widening of the hysteresis of martensite transformation.
13. L. Kosec, B. Kosec, M. Bizjak, Z. Krampuš, V Martinčič: New material for fusibles elements of low voltage fuses.  
Ecologically harmful cadmium was replaced and a low temperature SnBiSb alloy was developed for low voltage fuses. It is manufactured in form of wire with circular rectangular shape and used in industry.
14. K. A. Yushchenko, V. S. Savchenko, A. A. Nakonechny, A. A., Rabinovych, B. A. Gryaznov, A. P. Gopkalo, Yu. S. Nalimov: Fusion welding repair of GT blades of EP-539LM nickel alloy.  
Technology of welding repair of blades was developed ensuring defects free welds with the level of 0.70 for tensile properties and the level of 0.75 for longtime strength achieved. The repair does not affect the fatigue properties of the blades.