Head of Department: Associate Prof. Łukasz Rogal Ph.D., D.Sc.

Scientific Staff

Associate Prof. Anna Sypien, eng. Ph.D., D.Sc.

Associate Prof. Anna Wierzbicka-Miernik, Ph.D., D.Sc.

Engineering-technical Staff

Marek Kopyto, eng. Ph.D.

Grzegorz Garzel, eng. Ph.D.

Areas of the research:

Evolution of microstructure, thermal stability, phase composition and thermo-mechanical properties of the chosen multicomponent alloys, amorphous and micro-crystalline, involving melt-quenched nano-crystals.

Phase transformations and thermo-physical and thermo-mechanical properties of the chosen intermetallic phases. The subject directed on investigations of the relations between phase transformations, resulting microstructures and thermo-physical and thermo-mechanical properties of the phases. The investigations includes evolution of the metastable microstructure and it's relation to the phase transformations, especially eutectoid decomposition, in the case of the alloys of the formula Ni3(X,Y,Z), belonging to the continuous phase field in high temperature range and subdued to the eutectoid decomposition into pseudo-binary ordered phases of the Ni3X -Ni3Y-Ni3Z type, revealing also temperature dependence of the thermo-mechanical properties like Young modulus and yield strength.

Calculations and optimization of the multi component systems phase diagrams by the CALPHAD method. Experimental determination of thermodynamic properties of metallic and ceramic systems by electrochemical methods supported by DSC, DTA, EDS and XRD methods of analyses. The calculations and optimization of the phase diagrams by means of the software packages: ThermoCalc version S, Pandat 2013 (optimizer included), PanEngine 7. Simulations of the phase transformations diffusion controlled in alloys with use of the Dictra 23 program. Thermodynamic modeling of the particles size effect on the thermodynamic equilibriums in metallic systems.

Investigation of the thermal and thermo-mechanical properties of alloys and other materials and experimental verification of the phase diagrams. Determination of the temperature ranges and character of the phase transformations, heat capacity, mechanical properties and materials dimensions thermal stability ranges, verification of the characteristic points at the phase diagrams. Investigations of the decomposition and oxidation processes by DSC, TGA and thermo-mechanical analysis (TMA). Microstructure and chemical composition analysis by the scanning electron microscopy (SEM).

Development of micro casting by various induction melting methods: crucible melting, half-levitation (CCLM-cold crucible levitation melting) and levitation melting and by the rapid

solidification methods. Includes coarse grain, refinement and amorphous alloys preserving high purity and a wide range of the cooling rates.

New lead-free solder materials and soldering technologies (in cooperation with the DN-1 and DN7 Depts.). Micro structural characteristic and phase composition of the phases formed at the zone of the solder /substrate (SEM,TEM XRD methods) and strength of the interconnection.

European Union Projects

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COST - Action 531 - Lead-free solder materials, Task: Diffusion soldering- perspective technology of materials lead-free joining, IMMS PAS, 2002-2006.

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COST 535, Thermodynamics of Alloyed Aluminides, (Thalu), IMIM PAN, 2002-2006.

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COST - Action MP 0602 - Advanced solder materials for high temperature applications - HISOLD, Working group I - Complex study of thermodynamic and physico-chemical properties and structural characteristics of materials for potential use as high-temperature lead-free solders, Project: No. 85/N-COST/2007/0, 2007-2010.

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Operational Program Innovative Economy, co-financed by European Cohesion Funds, Reliability improvement of lead-free interconnections in electronic packages, Project No. WND-POIG.01.03.01-00-103/09, 2009-2012 (in cooperation with DN-7 department, project manager in IMMS PAS Prof. Paweł Zięba, Ph.D., D.Sc.).

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Advanced materials and their production technologies- ZAMAT, Project No. POIG.01.01.02-00-015/09-00, 2009-2014 (in cooperation with DN-1 department, project manager in IMMS PAS Prof. Władysław Gąsior, Ph.D, D.Sc.).

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Development of a sintering center and know-how exchange for non equilibrium sintering methods of advanced ceramic composite materials, REGPOT-CT-2013-316232-SINTERCER the 7th Framework Program EU, 2013-2016 (in cooperation with the Institute of Advanced Manufacturing Technology in Krakow, leader of the project Prof. Lucyna jaworska Ph.D., D.Sc.)

Projects founded by Ministry of Science and Higher Education

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Modern materials and processes for use in foundry industry, PBZ-KBN-114/T08/2004, Task No. 4, Levitation melting technique in the microcasting, IMMS PAS, 2004-2008

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Ni based glasses - nanocrystallization and mechanical properties- Project No. N 3T08A 067 28, 2005-2008.

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Corrosion study of SAC lead-free solders by liquid media (acid rains, sea water), Project No. N N507 443732, 2008-2010.

Projects founded by the National Science Centre

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Influence of selected alloying elements on the crystallization and mechanical properties of metallic glasses NiNb(ZrTi) and TiCuZr, Project No. N N507 303940, 2011-2014.

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Microstructural and kinetic characterization of the phenomena occurring at interphase boundaries in (Sn,Ni)/Cu diffusion couples, Project No. 2011/03/B/ST8/06158, 2012-2015.

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Microstructural and kinetic characterization of the phenomena occurring at the solder/substrate interfaces of the Ti-6Al-4V alloys brazed with the use of amorphous TiZrCuPd ribbons, Project No. UMO-2013/11/B/ST8/04286, 2014-2017.

Projects founded by the National Centre for Research and Development

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Modern, graphene containing composites on the base of copper and silver for the energetic and electronic industries.- GRAMCOM, GRAF-TECH, Task: Application of the HPT, severe plastic deformation method to the production of the graphene containing composites for the electrical contacts and heat abstracting substrates, 2013-2015 (Task lider Ph.D., D.Sc. Tomasz Czeppe, prof. PAS, coordinator in IMMS PAS Prof. J. Dutkiewicz, Ph.D, D.Sc.).

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In-line processing of n+/p and p/p+ junction systems for cheap photovoltaic module production, Project of the consortia of IMMS PAS. Inst. Of Catalysis and Surface Chemistry PAS and SINTEF - Norway, granted by NCRD in the frame of the Norway mechanism of financing, Project No POL-NOR/199380/89/2014 NCBiR, 2014-2016 (in cooperation with DN-7, dr. P. Panek is the task manager for Work Package 1 -,,Front and back doping of Si wafers by low cost method")

Projects in international cooperation

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Intermetallic phases, exhibiting magnetic properties, relation between microstructure, magnetic and thermal properties, in cooperation with the Institute for Metals Superplasticity Problems of the Russian Academy of Sciences, Ufa, Russia 2005-2007.

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The influence of large plastic strains on the structure and physical properties of Ni-based intermetallic phases and amorphous alloys, in cooperation with the Institute for Metals Superplasticity Problems of the Russian Academy of Sciences, Ufa, Russia 2008-2010.

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The influence of the intensive deformation on the structure and physical properties of Ni-based intermetallic phases of close packed structure and amorphous phases, in cooperation with the Institute for Metals Superplasticity Problems of the Russian Academy of Sciences, Ufa, Russia 2011-2013.

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Amorphous alloys, relaxation, viscosity, crystallization, mechanical and other properties for application; in cooperation with the Institute of Metal Science, Equipment and Technologies ‘Acad. Angel Balevski' with Hydroaeronautics Centre of the Bulgaria Academy of Sciences.

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The structure and properties of the complex amorphous-crystalline and crystalline-crystalline systems achieved by the severe plastic deformation, on the base of bilateral cooperation agreement with the Institute for Metals Superplasticity Problems of the Russian Academy of Sciences, Ufa, Russia.

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Metallic glasses: viscous flow, thermal stability in relation to mechanical properties. in cooperation with the Institute of Metal Science, Equipment and Technologies ‘Acad. Angel Balevski' with Hydroaeronautics Centre of the Bulgaria Academy of Sciences.

Students and Ph.D. trainings

B.Sc. degree supervising

Other activities and scientific achievements

Organization of the International Conference - Discussion Meeting on Thermodynamic of Alloys, TOFA 2008, 22-27 June 2008, Krakow;
Organization of the International Seminar and School of thermal analysis: "Practical Applications of Thermal Analysis Methods in Materials Science" IMMS PAS/Netzsch Comp., Krakow 2012.