

## The Head of the Department

Professor Natalia Sobczak, Ph.D.,D.Sc.

## Scientific Staff

Professor Boguslaw Major, Ph.D., D.Sc.

Associate Prof. Piotr Ozga, Ph. D., D. Sc.

Associate Prof. Przemysław Fima, Ph. D., D. Sc.

Janusz Pstrus, Ph. D.

Associate Prof. Adam Dębski, Ph.D., D.Sc.

Associate Prof. Tomasz Gancarz, Ph. D., D.Sc.

Honorata Kazimierczak, Ph. D.

Sylwia Terlicka, Ph. D.

Professor Władysław Gąsior, Ph.D, D.Sc. - Professor Senior

**Engineering -technical Staff**

## **PhD students**

Alexandra Dobosz, M.Sc.

Agnieszka Hara, M.Sc.

Miłosz Zabrocki, M.Sc.

## **Research area**

The laboratory of Theory of Metallurgical Processes has existed since its inception into scientific activity, first as the laboratory, in the structure of the Institute of Fundamental Technological Research in Warsaw and then as the Department of Fundamentals of Metallurgy, Institute of Fundamentals of Metallurgy and Institute of Metallurgy and Materials Science. Initially, research topics focused on measurements of metal activity in alloys. Over time, it has been extended including research on other properties, such as surface

tension and density. The last years of the twentieth and early twenty-first century is another period of broadening the spectrum of research on thermodynamic and physicochemical properties of lead-free solder. These include viscosity, specific resistance measurements, calorimetric measurements of formation enthalpy of intermetallic phases, changes of mixing enthalpy of liquid alloys, temperature transitions by thermal analysis, hydrogen adsorption / desorption testing and wettability of materials with lead-free solder alloys, soldering alloys and electrolytic production of solders and preparation of graphene layers. From the moment the Institute was founded, the Laboratory of Theory of Metallurgical Processes was headed by: prof. Aleksander Krupkowski, prof. Władysław Ptak, prof. Zbigniew Moser and from the year 2000 prof. Władysław Gąsior.

## **New ecological soldering alloys**

*Development of the SURDAT database of physicochemical properties of metals and alloys.*

*Research on ecological lead-free solders.*

*Modeling of physical properties of metal alloys (surface tension, viscosity).*

**Metallic materials for energy storage.**

*Measurements of metal activity by measuring the electromotive force of concentration cells.*

*Calorimetric studies of the enthalpy of creating intermetallic phases and changes in the enthalpy of mixing of two- and three-component alloys.*

*Research and modeling of physical properties of metal alloys (density, surface tension, viscosity).*

*Hydrogen absorption / desorption in alloys, chemical compounds and other materials.*

*Developing the ENTALL base of thermodynamic properties of energy storage materials.*

## **Research Projects**

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W. Gařsior - *Role of lithium in modification of Ag-Cu alloys.* Projekt 3 T08A 008 27, IMMS PAS 2004 - 2007.

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Z. Moser - *Development of SURDAT database. Viscosity measurements and wettability testing of Cu by lead-free solders,* IMMS PAS 2007 - 2010.

-

W. Zakulski - *Thermodynamic properties of Ca-Li alloys as the material for safety storage of the  $\alpha$  hydrogen,*

Project N508 379235 IMMS PAS 2008 - 2010.

-

P. Ozga - *The layers and the protective coatings on the basis of zinc alloys with ferrous metals and manganese for replacing cadmium coatings obtained by electrodepositing from complex solutions,* IMMS PAS 2007-2010.

-

W. Zakulski - *Lithium activity in Ca-Li alloys as the material for safety storage of the hydrogen.* Project N R07 0026 06/2009, IMMS PAS 2009-2011.



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W. Gařsior - *Advanced materials and their production technologies.* ZAMA  
T. Proj  
ect jointly financed by European Union and Poland, POIG.01.01.02-00-015/09-00, IMMS PAS.

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P. Ozga - *Advanced materials and their production technologies.* ZAMAT.  
Project jointly financed by European Union and Poland, POIG.01.01.02-00-015/09-00, IMMS PAS.

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J. Pstruś - *Advanced materials and their production technologies.* ZAMAT

.  
Project jointly financed by European Union and Poland, POIG.01.01.02-00-015/09-00, IMMS PAS.

-

W. Gaśior - *Phase equilibria in the Bi-In-Sn-Zn system.* Projekt Nr N N507 457237, IMMS PAS 2009-2012.

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A. Dębski - *Thermodynamic investigations of the Li-Sn alloys, as materials for safety storage of the hydrogen.* Project Nr IP2010 007170, IMMS PAS 2011.

-

Z. Moser - *New method of simultaneous measurements of the surface tension, density and viscosity of solder materials and new alloys for the automotive industry.*

International project Nr m

630/N-Kanada/2009/0, 2009-2013

-

P. Fima - *Thermodynamic properties and phase equilibria in Ag-Bi-Ni alloys* .

Project IP2012 035672, IMMS PAS, supervisor, 2013-2015

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T. Gancarz - *Physicochemical properties of*

*Sn-Zn+(Ga, Na) alloys* . Project  
2013/09/D/ST8/03991, IMMS PAS,  
supervisor, 2014-2017

-

*T. Gancarz - Effect of addition Na, Li and Si  
to eutectic ZnAl alloys on phenomena  
occurring at the interface of soldered joints*  
. Project IP2014 011473, IMMS PAS,  
supervisor, 2015-2017

-

*H. Kazimierczak - Electrodeposition of  
Zn-Mn-Mo alloy coatings from aqueous  
citrate baths* . Project  
Iuventus Plus, IMMS PAS, supervisor,  
2015-2017.

-

M. Trybuła - *Thermodynamic and thermophysical properties of liquid binary alloys. Theory versus experiment*

. Project PRELUDIUM, NCN No 011/03/N/ST8/05308, IMIM PAN, supervisor, 2012-2014

-

M. Trybuła - *Thermodynamic, structural and physicochemical properties of liquid Al-Li-Zn alloys*

. Project ETIUDA, NCN No 2014/12/T/ST8/00089, IMIM PAN, supervisor, 2014-2015.

-

R. Major, *Development strategies and applications of the multifunctional nanocomposite tribological ceramic/carbon coatings*, Projekt wymiany Polska-Austria (Joanneum Research - dr hab. Jurgen M. Lackner), supervisor, 2010-2011.

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R. Major, *New gradient materials fabricated by laser method for blood contact application*, Projekt wymiany Polska-Francja Polonium (National Polytechnique de Grenoble MINATEC prof. Franz Bruckert), supervisor, 2010-2011.

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R. Major, *Rozwój biomedycznych cienkich warstw dla urządzeń wspomagania serca: nowe strategie bazujące na próżniowym nanoszeniu samoorganizujących się biomateriałów*, Projekt wymiany Polska-Austria (Joanneum Research - dr hab. Jurgen M. Lackner) 023/2012/2013/2014 8548/R 12/R 14, supervisor, 2012-2014.

-

R. Major, *Self-assembling, biomimetic porous scaffolds in terms of inhibiting the activation of the coagulation system*, NCN, 2011/03/D/ST8/04103, supervisor, 2011-2014.

-

R. Major, *Inspirowane biologicznie materiały cienkowarstwowe o kontrolowanym udziale naprężeń własnych w aspekcie odtworzenia mikrośrodowiska dla komórek macierzystych*, NCN, 2014/13/B/ST8/04287, supervisor, 2014-2016.

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P. Fima, *Thermodynamics and structure of liquid Ag-Li-Sb alloys*, project 2015/19/B/ST8/01074, IMMS PAS, 2016-2019

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T. Gancarz, *Design and physicochemical, thermal properties of low temperature metal*



*alloys based on gallium*

,

Project 2016/21/B/ST8/00324,

2017-2019

-

W. Gařsior, Thermodynamic properties and structure of alloys from the Ge-In-Li system, projekt 2016/21/B/ST8/01031, IMIM PAN, 2017-2019

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A.Dębski, Thermodynamic characterization of the Ga-Li system, IMIM PAN, 2015-2018.

## **European Union Projects**

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COST Action 531, *Lead-free solders*, IMMS PAS, 2003-2006.

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COST Action 535, *Wytwarzanie i optymalizacja właściwości intermetalikó*w, IMMS PAS, 2004-2007.

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COST Action MP 0602- *Advanced solder materials for high temperature applications - HISOLD, Project: Complex study of*

*thermodynamic and physicochemical properties and structural characteristics of materials for potential use as high-temperature lead-free solders*

, Task: Physicochemical properties of high temperature solders, grant No. 85/N-COST/2007/0, IMMS PAS, 2007-2010.

-

COST Action MP1407, *Electrochemical processing methodologies and corrosion protection for device and systems miniaturization (e-MINDS)*, 2015-2019.

## International cooperation

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T. Gancarz, W. Gařsior, *Investigations of viscosity, surface tension and density of alloys and metals*, University of Alberta, Edmonton, Canada.

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A. Dębski, W. Gařsior, *Calorimetric studies and phase equilibria modelling*, Physics Engineering Department, Engineering Faculty of the University of Porto, Portugal.

-

M. Trybula, W. Gařsior, *Quantum modeling of liquid materials properties*. Science et Ingénierie des Matériaux et Procédés, Grenoble Institute of Technology, France

-

P. Fima, *Thermodynamics of lithium alloys for novel anode materials in batteries*, Department of Inorganic Chemistry/Materials Chemistry, University of Vienna, Austria.

-

R. Major, *Modification of surface by physical vacuum methods*,  
Joanneum Research, Materials,  
Austria

-

R. Major, *Molecular biology problems in materials science*, CNRS  
w Institut National Polytechnique de  
Grenoble, Minatec - INPG Laboratoire  
des Matériaux et Du Génie Physique,  
France.

-

P. Fima, *Thermodynamics of lithium alloys for novel anode materials in batteries*, Department of Inorganic Chemistry - functional Materials, University of Vienna, Austria.

-

*The characterization of new alloys for automotive industry. (2017-2022)*  
University of Alberta, Faculty of Engineering, Edmonton, Alberta, Canada Prof. Hani Henein

-

*The study of physicochemical properties of low temperature alloys.* (2017-2022). Department of Metal Physics, Ivan Franko National University, Lviv, Ukraine Prof. Yuriy Plevachuk

## **PhD dissertation**

2008 - J. Pstruś, *Physicochemica*



*I properties new solder alloys on  
the example of the Sn-Zn-In  
system,* IMMS  
PAS, (Supervisor: Z. Moser)

2012 - A. Dębski, *Heat of  
formation of intermetallic phases  
from the Al-Fe-Ni-Ti system*  
, IMMS PAS, (Supervisor: W.  
Gąsior)

2013 - T. Gancarz, *Thermophysic*

*al properties of Sb-Sn-Zn liquid  
alloys,* IMMS  
PAS, (Supervisor: W. Gąsior)

2014 - H. Kazimierczak,  
Electrodeposition of Zn-Mo layers  
Electrodeposition of Zn-Mo layers  
from aqueous citrate solution,  
IMIM PAN, (Supervisor: P.  
Ozga).

2015 - M. Trybuła,

Thermodynamic, structural and thermophysical properties of liquid Al-Li-Zn, (IMMS PAS, PhD advisor: W. Gąsior)

2017 - M. Słupska, The electrodeposition of Sn-Zn-Cu layers from citrate solutions, (IMMS PAS, PhD advisor: P. Ozga)

# PhD in progress

Agnieszka Hara - PhD  
advisor: P. Ozga

Sylwia Terlicka - PhD advisor:  
P. Fima

Monika Bugajska - PhD

advisor: P. Fima

Miłosz Zabrocki -  
"Thermodynamic properties of  
liquid alloys from the  
Ga-Ge-Li and Ga-In-Li  
systems"

# Other activities and scientific achievements

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Z. Moser, CALPHAD  
XXXIII Conference,  
Kraków, Polska, (2004),  
chairman.

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Z. Moser, W. Gąsior, A.  
Dębski, J. Pstruś, *SURDA*  
*T. Data base of lead-free*  
*soldering materials,*  
Monograph, Institute of  
Metallurgy and Materials  
Science Polish Academy of  
Sciences, Kraków 2007,  
ISBN 83-60768-01-3.

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Z. Moser, W. Gąsior, A.  
Dębski, J. Pstruś, *SURDA*  
*T. Data base of lead-free*  
*soldering materials.*  
Software, Institute of  
Metallurgy and Materials  
Science Polish Academy of  
Sciences, Kraków 2007,  
ISBN 83-60768-01-3.

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Z. Zakulski, TOFA 2008  
Conference, Kraków,  
Poland, Secretary (2008).

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Z. Moser, TOFA 2008  
Conference, Kraków,  
Poland, Member  
International Advisory  
Board (2008).

-

Z. Moser, W. Gąsior, A.  
Dębski, J. Pstruś, *SURDA*  
*T 2. Data base of*  
*physicochemical properties*  
*of selected solders.*  
Monograph, Institute of  
Metallurgy and Materials  
Science Polish Academy of  
Sciences, Kraków 2011  
(prepared to edition).

-

Z. Moser, W. Gaśior, A.  
Dębski, J. Pstruś, *SURDA*  
*T 2. Data base of*  
*physicochemical properties*  
*of selected solders. S*  
oftware, Institute of  
Metallurgy and Materials  
Science Polish Academy of  
Sciences, Kraków 2011  
(prepared to edition).

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W. Gąsior, Member of  
Outer Experts Team for the  
Delhi Analysis of National  
Program Foresight Poland  
2020, 2008

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Member of Social Council  
of Non-Ferrous Metals

Faculty of University of  
Science and Technology  
-AGH.

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W.Gąsior, W. Zakulski, P.  
Fima, International  
Symposium on Advanced  
Materials and  
Technologies of  
Manufacture, March 28-29,

2014, Kraków, Poland.

-

H. Kazimierczak, *Electrode position of Zn-Mo layers from aqueous citrate solution* ,

Aleksander Krupkowski  
Institute of Metallurgy and  
Materials Science Polish  
Academy of Sciences,

Kraków 2007.

-

R. Major, *Advanced  
Materials and  
Technologies AMT2010*  
, International Conference,  
Zakopane, Poland,  
Member International  
Advisory Board (2010).

-

R. Major, *Nanostructural materials for implants and cardiovascular biomedical devices* ,

International Conference,  
Zabrze, Poland, Member  
International Advisory  
Board (2010).

-



R. Major, *Polish Society for Biomaterials*,  
Member (2014)

-

R. Major, *Committee on Materials Science Polish Academy of Sciences*,  
Member of Task Force on Biomaterials (2014).

