

PROFESSOR ZBIGNIEW MOSER - BIOGRAPHY & BIBLIOGRAPHY

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On 13 April, 2011, Professor Zbigniew MOSER passed away. He was a Member of Editorial Board of the *Journal of Mining and Metallurgy*, Section B – Metallurgy, as well as the Chairman of the *Associated Phase Diagram and Thermodynamics Committee* (Poland, Bosnia&Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Montenegro, Romania Serbia, Slovakia, and Slovenia).

BIOGRAPHY

Course of academic career

Professor Zbigniew Moser was born on 1 April, 1932, in Krakow, Poland. He graduated as a bachelor from AGH – Technical University, Faculty of Ceramics, Krakow (1956) and next as a master at the Jagiellonian University, Faculty of Chemistry, Krakow (1959). Starting from this year, all his scientific carrier was connected with his employment at the Aleksander Krupkowski's Institute of Metallurgy and Materials Science (IMMS), Polish Academy of Sciences (PAS), in Krakow (former name: Institute for Metal Research, PAS).

On presenting the thesis “*Determination of the thermodynamic quantities of binary and ternary metallic solutions*” in 1965, he graduated as a doctor from Institute of Fundamental Technological Research, PAS, Warszawa. At the same Institute, his postdoctoral degree, entitled „*The problem of determining the distribution coefficients in molten binary and ternary solutions in low zinc concentrations*”, was accepted in 1970.

In 1981, by the decision of the President of the Republic of Poland, he became a professor of metallurgy.

From 1970 to 2004, he headed the Laboratory of the Theory of Metallurgical Processes at the Aleksander Krupkowski's Institute of Metallurgy and Materials Science (IMMS), Polish Academy of Sciences (PAS), in Krakow, having a substantial staff of co-workers: Krzysztof Fitzner, Wladyslaw Gasior, Marian Kucharski, Krzysztof Rzyman, Jan Wypartowicz, Leszek Zabdyr, Wojciech Zakulski,

and finally, also Adam Debski and Janusz Pstrus.

In the years 1999-2003, he was the Director of IMMS – PAS, whereas in 2007–2010, he was the Chairman of the Scientific Board of the Institute.

Experimental achievements

In the first many years of his work, prof. Moser himself, as well as in co-operation with prof. Wladyslaw Ptak, initiated systematic experimental investigations of many binary, ternary, quaternary and quinary Zn-based, Cd-based, In-based and Mg-based alloys in the liquid state, with the use of the galvanic cells methods with a molten LiCl – KCl electrolyte. One of the goals of these studies was a verification of the Krupkowski's formalisms, who, in 1950, offered [1] his own solution of the Gibbs-Duhem equation, linking together the activity coefficients of the components forming the solution. At that time, besides the graphic method of Darken, this was the only known way of interpreting the thermodynamic properties of a multicomponent solution. For the verification of the Krupkowski's formalism for the Zn-Sn-Cd-Pb-Bi quinary liquid alloys [2] - during ten years - 10 binary [3], 10 ternary [4] and 5 quaternary [5] subsystems were investigated. Also positive verification for molten salts were found [6].

In the 70's and 80's, the range of experimental techniques used by prof. Moser's staff was extended by the EMF methods, with a solid electrolyte, directed towards the solid phases and the oxide systems [7], as well as by the calorimetric measurements of the enthalpies of mixing of liquid alloys [8]. The coulometric titration technique, based on an

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electrochemical cell with a solid electrolyte, was used to measure the oxygen activity in liquid alloys [9]. Solid electrolytes were used to measure the activities in the solid state [10] and next - for the phase diagram calculations [11].

In the following years, the calorimetric technique was extended by the measurements of the enthalpies of formation of intermetallic phases [12].

Also, the measurements of the density and surface tension of molten salts, pure metals and alloys were performed with the application of the maximal bubble pressure method [13].

In the field of experimental thermodynamic studies of advanced materials, his activity was also concentrated on the phase diagram calculations [14] and the correlation between structure and physical properties [15]. These studies resulted in a participation in the Phase Diagram Evaluation Program, established by the *ASM International*. Combining all the available literature thermodynamic data, critically evaluated phase diagrams were calculated [16].

International co-operation

From the beginning of his scientific carrier, prof. Moser gave his due attention to international scientific contacts and co-operation with many scientific foreign centers working in the field of thermodynamics and phase diagram calculations. The list of these centers is very long and includes institutions in Europe, the USA, Canada and Japan: Technical University, Trondheim (Norway), University of Manchester (UK), St. Petersburg State Polytechnic University (former Leningrad Polytechnic Institute) (Russia), Institute of Physical Chemistry "I.G. Murgulescu" of the Romanian Academy, Bucharest (Romania), University of Vienna (Austria), Max-Planck-Institut für Metallforschung, Stuttgart (Germany), Université Nancy (France), Centre de Thermodynamique et de Microcalorimétrie du CNRS, Marseille (France), University of Saarland, Saarbrücken (Germany), Albany Research Center, Bureau of Mines, US Department of the Interior, Albany, Oregon (USA), Iowa State University, Ames (USA), Brookhaven National Laboratory, Brookhaven (USA), École Polytechnic de Montreal, Montreal (Canada), Osaka University, Osaka (Japan), Tohoku University, Sendai (Japan), Man Labs, Inc., Cambridge, Massachusetts (USA), American Society for Metals, Materials Park, Ohio (USA), National Institute of Standards and Technology (NIST) (USA), University of Alberta,

Edmonton (Canada)

For example, the scientific cooperation in the 90's with Max-Planck-Institute (MPI) in Stuttgart, in the area of light alloys with Li additions, resulted in a Collaborative Project entitled *Thermodynamics and the Phase Diagram of the Al-Li-Mg System* [17], financed by NATO (1993 – 1996).

The subject matter of lithium-based alloys was also present in prof. Moser's laboratory, where systematic investigations of lithium activity were started and continued in the 90's, in co-operation with the University of Saarbrücken. Over 20 publications [18] in domestic and foreign journals were published and the results were presented at several international conferences [19].

Participation in scientific conferences

Another area which prof. Moser emphasized was the participation in many valuable international conferences, such as *International Society of Electrochemistry*, *Thermodynamics of Alloys - TOFA*, or *Calphad*.

Starting from Calphad IX, up to his death, he took part in almost all the *Calphad* conferences. Although today this fact may seem as not unusual, in the 60's and 70's, it was not typical as well as difficult, regarding the political and economic relations in Poland, where even receiving a passport was not easy.

Several times, prof. Moser was the chairman of conference sessions, in which he took part.

Publications

Prof. Moser and the members of his staff published the results of their experiments and calculations in well known journals, such as *Journal of the Electrochemical Society*, *Canadian Metallurgical Quarterly*, *Zeitschrift für Metallkunde*, *Bulletin of Alloy Phase Diagrams*, *Calphad*, *Metallurgical Transactions*, *Journal of Phase Equilibria*, *Journal of Non-Crystalline Solids*, *Acta Metallurgica*. He was the author of 210 printed papers (160 papers were indexed by Institute for Scientific Information in Philadelphia), 95 conference lectures, and 9 monographs or chapters in monographs.

Membership in APDIC – Polish Phase Diagram Committee – Associated Committee

Since the 70's, it was observed in the world-wide forums that an organizational trends were going towards an international co-operation between scientific centres dealing with the experimental measurements of the thermodynamic properties of

alloys, as well as modelling and phase diagram calculations from the thermodynamic database. In order to coordinate these international activities, in 1986, the *Alloy Phase Diagram International Commission (APDIC)* was formed. Prof. Zbigniew Moser was the chairman of the *Polish Phase Diagram Committee* [20], which was accepted to APDIC in 1994. *Polish Phase Diagram Committee* gathered several Polish scientific centers working in the basic studies of thermodynamic properties and phase diagram calculations.

At the end of 1999, in Kraków, prof. Moser and his co-workers organized a one-day seminar with the participation of representatives of universities and Academies of Sciences from the South and East European countries. During the discussion, the common experiences and the joint interests were evaluated by the participants of the meeting, and it was decided to transform *Polish Phase Diagram Committee* into an new international organization (its initial name was *Central Europe Phase Diagram and Thermodynamic Committee*), which was finally named *Associated Phase Diagram and Thermodynamics Committee (APDTC)* [21-22]. It, at present, consists of 11 countries: Poland, Bosnia&Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Montenegro, Romania Serbia, Slovakia, and Slovenia. From the beginning up to his death, prof. Moser was the chairman of the *Associated Committee*.

Professor Moser represented *Associated Committee* during the APDIC Meetings organized each year just before the Calphad conferences.

Pb-free materials - Experiments and modeling - The data-base SURDAT

The ecological and health reasons has driven the European Commission to issue, so called, the RoHS Directive, which from 1 July 2006, has required the removal of Pb from all the existing products and technological processes. In the face of the implementation of that directive, within the frames of the 6-Framework Program, the European Union approved the ELFNET project – The European Lead-Free Soldering Network. The ELFNET included 36 partners from 19 European countries. Prof. Moser was the coordinator (2004-2007) of the ELFNET project in Poland.

Since 2000, systematic studies on Pb-free soldering materials by the maximum bubble pressure method and the dilatometric technique were

undertaken in prof. Moser's laboratory, which involved the modeling and the thermodynamic investigations of the density, surface tension, wettability angle, interfacial tension and electric property studies of the new alloys being the candidates for the low-melting solders, based on the Sn-Ag, Sn-Ag-Cu [23] and Sn-Zn eutectics [24]. Also, the materials of the melting temperatures from the range 250–400°C and higher were tested. Within the frames of these investigations, prof. Moser participated in the COST-531 Action (“Lead-free Solder Materials”) and COST-MP 0602 Action (“Advanced Solder Materials for High Temperature Application (HISOLD)”).

On the basis of the results of his own investigations mentioned above, and next - also with the application of the literature data - prof. Moser's staff created the SURDAT data base [25]. The SURDAT database includes the physical properties of Pb-free solders, comprising the experimental and the modeled surface tension, the density and the molar volumes of 10 pure metals, 12 binary, 4 ternary and 2 quaternary systems (v.1, 2007). In its enlarged version (v.2, 2010) the meniscographic, calculated and experimental data on contact angles and viscosity, for new 18 binary, 16 ternary, 4 quaternary, and 1 quinary systems, were added. Also the NIST data base was included. The SURDAT data base is offered free of charge at the IMMS-PAS website [26].

Organization of conferences

Prof. Moser was the organizer or a co-organizer of several domestic and international conferences.

In 1999, prof. Moser and his staff - the members of the *Polish Phase Diagram Committee* - organized a one-day seminar with the representatives from the South and East-European countries, devoted to the establishment of a new international committee - *Associated Phase Diagram and Thermodynamics Committee* – which was chaired by prof. Moser.

In 2000, in Krakow, the Polish members of the *Associated Committee* organized a 3-day international conference: “Discussion Meeting on Thermodynamics of Solutions”. About 50 participants from 12 countries gave lectures during the conference, chaired by prof. Moser.

In 2004, the main international congress at which the most current achievements in the field of metallurgy, phase diagram calculations and computational thermochemistry are presented - the CALPHAD XXXIII – was organized in Krakow, for

the first time in that part of Europe. The 5-day conference was organized by IMMS-PAS in cooperation with the Jagiellonian University, Krakow, AGH-University of Science and Technology, Krakow, and Committee of Metallurgy PAS. Professor Moser was the chairman of the Polish organizational committee. Just before the conference, the APDIC Meeting was held in Krakow.

In 2003 and 2005, prof. Moser was the chairman of the *Associated Committee* workshops organized by him and his staff in Krakow.

He was also the chairman of several workshops organized within the frames of the ELFNET project, related to the implementation of lead-free materials in the electronic industry.

Honors and awards

Professor Moser was honored with numerous scientific awards - several team-work and individual awards of the Chairman of the Polish Academy of Sciences. Category Editor in ASM International Program on Binary Phase Diagrams, Member of the *Alloy Phase Diagram International Commission* (APDIC) (since 1994), Chairman of the *Polish Phase Diagram Committee* (since 1994), Chairman of the *Associated Phase Diagram and Thermodynamics Committee* (Poland, Bulgaria, Czech Republic, Hungary, Slovakia and Yugoslavia) (since 2001). Awarded by the Polish President with the Officers' Cross of the Order of Polonia Restituta, and the Knight's Cross Order of Polonia Restituta

Editor-in-chief

Professor Moser was the Editor-in-chief of the *Archives of Metallurgy and Materials*, Poland (since 1990). Thanks to his insistent efforts, the journal was incorporated into the list of the Institute for Scientific Information in Philadelphia: SciSearch (the Science Citation Index - Expanded), Research Alert, Materials Science Citation Index, and Current Contents / Engineering, Computing and Technology. The articles published in the *Archives of Metallurgy and Materials* are also indexed or abstracted by Cambridge Scientific Abstracts. The access to the current issues of the Journal is also possible through the Versita publisher [27], as well as through the IMMS-PAS website [28].

Associate Editor

He was the Associate Editor in the *Journal of Phase Equilibria*, USA (since 1990), *Journal of*

Mining and Metallurgy, Serbia (since 1997), *Materials Transactions*, Japan (since 2001),

Educational activities

He gave lectures for graduate students, supervisor of several Ph.D. theses.

Memberships

Professor Moser was a member of the Polish Academy of Art and Sciences (since 1993), member of the Committee of Metallurgy PAS, member of International Council of Alloy Phase Diagrams in ASM International (1982-1987), member of CODATA (since 1984), member of the Research Council of the Institute of Metallurgy and Materials Science, Polish Academy of Sciences.

From the moment of its establishment, he was a member of the Trade Union "Solidarność".

A very important aspect characterizing the person of Professor Moser was closely connected with the terms: "good results of experiments", "high-level standard of publications printed in well known journals", "numerous presentations of results at famous conferences".

Professor Zbigniew Moser will remain in our memory as a passionate scientist, closely linked with IMMS-PAS, but during his long carrier, always open to the world-wide scientific trends, international connections and co-operations, and also an initiator of new research fields, new techniques and research projects. He remained active until his last day.

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