



In Memoriam

Professor Zbigniew Stanisław Moser: Scientist, Organizer, and Friend* (1932-2011)

Professor Zbigniew Moser was born on April 1, 1932 in Kraków, where he spent his childhood. He studied ceramics at the Academy of Mining and Metallurgy and then chemistry at Jagiellonian University, Kraków. In 1956 he graduated with the degree of Master of Chemistry. In the same year he began to work in the Laboratory of Metallurgical Research of Polish Academy of Sciences, now Aleksander Krupkowski Institute of Metallurgy and Materials Science, and he became devoted to research studies in the Institute. The task of his doctoral thesis was: *Determination of the thermodynamic properties of two- and three component alloys* and the habilitation thesis: *The problem of determination of the interaction coefficients in binary and ternary solutions for the low concentration of zinc*. In 1981, he was awarded a professorship of technical sciences by the President of Poland.

The range of investigations in which Professor Zbigniew Moser was engaged is impressive. When he started his work in the Institute he concentrated mainly on the activity of metals in alloys measuring the electromotive force of concentration cells. Those examinations served among others to verify Krupkowski's Equations of temperature-concentration dependences of excess Gibbs free energy in binary and multi-component alloys. Those problems were considered in both his doctorate thesis as well as in his habilitation work. He published dozens of articles on the subject in recognized journals both within Poland and in numerous other countries.

Apart from the studies of activity with the use of galvanic cells, after he accomplished his habilitation work, he directed his interests towards activity of components of chloride solutions of molten salts using the cells of formation type with Cl gaseous reference electrode, inspired probably by world trends as well as reports of Professor Pelton in Canada, with whom he began a cooperation. He referred to their discussions many times, always underlining Professor Pelton's willingness to help to solve research problems that occurred. That new research branch was continued in the Institute for almost 10 years and was later extended over the surface tension of binary alloys of Ag chlorides with metal chlorides of the first group of the element table. The results of the investigations were presented during several conferences and were published in international periodicals. The subject area was terminated at the beginning of the 1980s because our interests changed over to another interesting scientific venture: activity measurements of alloys containing the lightest metal of all, i.e. lithium. Thermodynamic investigation of lithium alloys, which is extremely difficult to realize without proper back-up facilities, was discussed and considered by the Professor's team since the late 1970s.

I assume that this new area of investigations was somewhat stimulated by Professor Moser's cooperation and friendship with J.F. Smith from Iowa State University, USA, whom Professor Moser met for the first time in 1972 at a Thermodynamics meeting organized by Bruno Predel in Munster, Germany. It was an impressive meeting since two of the best known German thermodynamicists, Carl Wagner and Oswald Kubaschewski, took part in it, as well as other well-known scientists, such as Larry Kaufman, Leo Lukas, Himo Ansara, and Philip Spencer, who together a short time later formed the nucleus of what has come down to the present as the Calphad Group.

Two years later, Professor Moser was invited by J.F. Smith for a 6-month appointment as a visiting professor and worked in his group at the Ames Laboratory at Iowa State University. These two friends published the overview of the literature data on the phase diagram and thermodynamics of the Pb-Mg system in 1975 (Z. Moser and J.F. Smith, *Thermodynamic Properties of Magnesium-Lead Alloys*, *Metall. Trans.*, 1975, **6B**, p 457-460), and a year later on lithium alloys (J.F. Smith and Z. Moser, *Thermodynamic Properties of Binary Lithium Systems—A Review*, *J. Nucl. Mater.*, 1976, **59**, p. 158-174). The Mg-Pb paper

***Editor's Note:** Professor Moser was both an Associate Editor of this Journal and a close personal friend. I will certainly miss him in both categories.

was essentially the final publication of his efforts to define the conditions necessary for validity of Krupkowski's Equation, but the Li alloy paper opened the door to a new area of research.

The studies of Li-alloys were immensely interesting from the application point of view. First, because alloys containing lithium were predicted as materials for new-generation batteries of general use, as well as for high-temperature rechargeable cells and galvanic cells of excellent exploitation parameters. Second, because the lithium addition to alloys used in flying objects decreases their density, which in turn lowers the consumption of fuel and exploitation costs, and third, because of the possible use of lithium alloys in fusion reactors. Thermodynamic experiments were already initiated in 1979; however, because of technical difficulties with obtaining a proper protective atmosphere they could not be started, in spite of the construction of a glove box with a protective atmosphere. Also the appropriate materials for the purification of the neutral gas atmosphere from the components, which would react with the lithium, were unavailable. The team had too little experience in the subject. But Professor Moser began cooperation with Professor G. Schwitzgebel, University of Saarbrücken, Germany, where the author could gain experience on the experiments on alloys with lithium and after coming home he was able to build the glove box with a system of argon purification. Then he began activity measurements in liquid and solid alloys followed by measurements of densities and chemical diffusion coefficients.

The purchase in 1987 of a professional glove box with the purification system made the experiments easier. The results were published in more than 20 articles, of which Professor Moser was co-author.

The next subject of Professor Moser's interest was the investigation of ecological, lead-free materials, which could stand for solders containing lead. In that subject, he took advantage of his earlier experience gained during research on physical and chemical properties like surface tension, density, and mole volume of liquid molten salts. Thanks to that, the measurements of surface tension could be immediately started, which enabled the assessment of the influence of various modifiers on wettability properties of alloys based on binary and ternary eutectics (Ag-Sn, Sn-Zn, Ag-Cu-Sn). Professor Moser cooperated on that subject with Tele- and Radio-Technical Institute, Institute of Non-Ferrous Metals, Warsaw Technical University, and later with the Institute of Electrotechnics. Their research groups extended the area of conducted experiments over meniscographic, electrical, and strength measurements of solders and soldered joints. The cooperation contributed also to the incorporation of dilatometric, specific resistivity, and wettability angle, as well as viscosity measurements, into the research procedures of IMMS PAS. As the result of long years of research, dozens of publications on lead-free solders appeared in the international scientific literature, as well as the electronic database SURDAT edited in 2007. Unfortunately, Professor Moser died before the second edition of the SURDAT database, largely widened with new systems and properties, could be published. Acting within the framework of the international net ELFNET and Polish scientific net Advanced Soldering Materials, he was an active promoter of the investigation and application of lead-free soldering materials.

The calorimetric investigations of liquid alloys, which were included in the Institute research program, had been first carried out in the 1970s by Professor Moser in cooperation with Professor B. Predel and with Professor F. Sommer, Max-Planck Institute, Stuttgart. That subject matter was passed over to one of his closest co-workers, Professor K. Rzyman, at present at Silesian Technical University, and expanded with research on formation enthalpy of intermetallic phases, which had been continued in the Laboratory of Metallurgical Processes, on alloys for safe storage of hydrogen.

After Professor Moser retired, he still continued his scientific activity, mainly in the area of lead-free solders, in the group of his long-term co-worker (the author) as a head of research projects financed by the Polish Ministry of Science and Higher Education. One of his last activities was establishing cooperation with Professor Hani Henein, Alberta University, Edmonton, Canada, in order to adapt a new method of surface tension, density, and viscosity measurements based on an analysis of liquid outflow rate from a container through a capillary hole.

Professor Zbigniew Moser proved he was a good organizer of research life. In 2001 he erected the Polish Committee of Phase Equilibria and in 2004 the Associated Phase Diagram and Thermodynamic Committee, in which 11 countries from Central Europe participated as part of the Alloy Phase Diagram International Commission. Additionally, Professor Moser was a member of the following international and domestic science organizations:

- Polish Phase Diagram Committee, ASM International
- National Committee for cooperation with the Associated Phase Diagram International Committee (APDIC)
- Alloy Phase Diagram International Commission
- Associated Phase Diagram and Thermodynamics Committee, ASM International
- Section Member of the Theory of Metallurgical Processes of Metallurgy Committee of the Polish Academy of Sciences
- National Committee for cooperation with the Committee on Data for Science and Technology (CODATA)

From 1980 to 1985 he was a Category Editor in the ASM International Phase Diagram Program. He served as an Associate Editor of this journal from its inception in 1991 until the time of his passing. He was also an associate editor for the *Journal of*

Mining and Metallurgy (1998) and *Materials Transactions* (2001). Since 1980, he was also the editor of *Archives of Metallurgy* and since 2004 of *Archives of Metallurgy and Materials*.

Professor Moser was the author and co-author of 210 articles in the following Journals: *Progress in Materials Science*, *Metallurgical and Materials Transactions*, *Canadian Metallurgical Quarterly*, *Journal of the Electrochemical Society*, *Metallurgical and Materials Transactions*, *Bulletin of Alloy Phase Diagrams*, *CALPHAD*, *Journal of Phase Equilibria*, *Journal of Phase Equilibria and Diffusion*, *Zeitschrift für Metallkunde*, *Archives of Metallurgy and Materials*, *Bull. Pol. Acad. Sci.*, *Archiwum Hutnictwa*, *Rudy i Metale*, and *Inżynieria Materiałowa*. He attended about 100 international and domestic conferences. Additionally, he was the author of nine monographs or chapters in monographs, and four times he was a thesis supervisor. Zbigniew Moser cooperated with the researchers of such institutes and universities as the Technical University of Norway, Atomic Energy Commission at Iowa State University, Max-Planck Institut für Metallforschung in Stuttgart, Tohoku University in Sendai, University of Alberta in Edmonton, Centre de Recherches de Microcalorimetrie et de Thermochimie du C.N.R.S. in Marseille, Osaka University, Universität des Saarlandes in Saarbrücken, and the Albany Research Center, Bureau of Mines.

International and national scientific projects were the activities he most highly appreciated and it was very important to him to attend to their realization. Therefore, if at all possible, he always made the effort to be a supervisor or a contactor of such research projects. In that way, during the last 20 years he participated in 12 projects on the measurements of activity of alloy components, diffusion coefficient, modeling and investigations of surface tension and viscosity, meniscographic investigations and wettability study, and mechanical and electrical properties of lead-free low and high temperature soldering materials.

For his science, education, and organization activities, Zbigniew Moser was honored in 1988 with the Maria Skłodowska—Curie Foundation Reward, and in 1989 he was awarded by the President of the IV Division (Technical Sciences) of the Polish Academy of Sciences.

Between 1999 and 2003 he was the Director of the Institute of Metallurgy and Materials Science, and with the board of management he began to modernize the research program as well as renovate the Institute.

The President of Poland honored Professor Zbigniew Moser with the Golden Cross of Merit, the Knight's Cross Order of Polonia Restituta, and the Officer's Cross Order of Polonia Restituta.

With the passing of Professor Moser on April 13, 2011, the international and Polish science community lost an excellent scientist, colleague, and friend.

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