ADVANCED MATERIALS

scale, although the more classical methods of sensing electromagnetic interactions between radiation and matter are being used continuously. In kinetic research it is found that in situ experiments, which for solids often mean high temperature experiments, are absolutely necessary. However, this makes the application of IR and visible light spectroscopy a most difficult task.

In a way it was interesting to note that electron microscopy is not used more by solid state physical chemists – at least in Germany. After all it is the (periodic) structure that distinguishes the solid from the fluid state and determines most of its properties including the kinetic and the dynamic ones, and high resolution electron microscopy offers spatial resolution on an atomic scale. Therefore it seems clear that electron microscopy will increasingly help us to understand the basis of solid state kinetics: the defect in the solid state. Additionally, modern chemical analysis results in a much better characterization of the solids under investigation than ever before. This is most important with regard to the fact that it is always the crystal defect, including chemical impurities, that (as is well known in semiconductor technology) govern many of the crystal properties.

In conclusion: The Bunsen-meeting has again illustrated the interdisciplinary character of physical chemistry and has fulfilled its role of promoting the exchange of ideas, this year in particular between the different groups which work in the broad field of solid state science.

[1] S. Clough, *Adv. Mater. 1989*, 296; *Angew. Chem. Int. Ed. Engl. Adv. Mater.* 28 (1989) 1124; Angew. Chem. Adv. Mater. *101* (1989) 1150.
[2] H. Sixl, W. Groh, D. Lupo, *Adv. Mater. 1989*, No. 11; *Angew. Chem. Int. Ed. Engl. Adv. Mater. 28* (1989) No. 11; *Angew. Chem. Adv. Mater. 101* (1989) No. 11.

Sol–Gel Processing in Bad Honnef

By Hans Reuter*

The 52nd seminar of the Dr. *Wilhelm Hereaus* and *Else Hereaus* Foundation entitled "Sol–Gel Processing for Glasses, Ceramics and Inorganic–Organic Polymers" was held from Monday, May 22nd, through Wednesday, May 24th, 1989 at the Physikzentrum in Bad Honnef, FRG.

Basically the expression "Sol–Gel Process" means the formation of an amorphous solid, the gel, starting from a homogeneous liquid, a molecular dispersion or colloidal solution. The great amount of scientific and technological interest devoted to this process ranges from molecular chemistry to material science. One aim of the seminar was to bring together, in a small circle, scientists from these different fields to discuss in an interdisciplinary manner the numerous aspects of sol–gel-processing. Twenty invited speakers and about thirty further participants attended the meeting coming from both university laboratories and industry.

An instructive overview of the present industrial application of the sol–gel technique was given in the paper "Sol–Gel 1969–1989, Paths of Development and Products, Especially the Newer Ones" from *H. Dislich* (FRG), who also showed some remarkable examples of industrially fabricated, sol–gel derived products. Complementing this, *D. R. Uhlmann* (USA) illustrated in his lecture "General View of Sol–Gel Technologies" not only the present state of the art developments and the numerous unsolved problems but also the future possibilities of the technology.

One main problem is, that there is only little known about the chemistry which happens during the sol to gel transformation. This was analyzed in two papers. In the first one, "Monoorgano Tin Compounds as Model Substances for the Investigation of the Sol–Gel Process", *M. Jansen* (FRG) showed that with organometallic precursors it is possible to isolate crystalline oligomers, which can be studied by X-ray structure analysis in order to see directly how i.e. the solvent may influence the reaction path. In the second paper "Sol–Gel Chemistry of Transition Metal Oxides", *C. Sanchez* (France) demonstrated, using titanium alkoxides as an example, not only the role of solvent molecules but also that of other chemical additives like catalysts, stabilizing agents or drying control chemical additives.

The processes following gel formation, like drying and densification, were reviewed in the lectures of *G. W. Scherer* (USA) who talked about "Hypercritical Drying", "Aging and Syneresis" and "Sintering of Gels", while *D. J. Brinker* (USA) discussed the "Fundamentals of Thin Film Formation from Sol–Gel Solution" and the "Spinnability of Silica Sols: Structural and Rheological Criteria" dealing with the more practical aspects.

New experimental paths were pointed out by *C. Rüssel* (FRG) "Non-Oxide Ceramics by Sol–Gel Techniques" mak-

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ing AlN by anodic dissolution of the metal in amines, by *U. Schubert* (FRG) "Sol–Gel Processing of Transition Metal Complexes" describing materials in which a transition metal complex moiety is bound by an inert spacer and an anchoring group to a silica gel matrix, and by *H. Schmidt* (FRG), who gave in his paper "Inorganic–Organic Polymers by Sol–Gel Techniques" first impressions about the manifold possibilities of organic modified silicates.

Many of the papers dealt with the possible applications of sol–gel derived materials. *J. Fricke* (FRG) "SiO_2-Aerogels—Structure, Properties, Applications" demonstrated that aerogels, due to their porosity, have very unusual but useful properties. Another example was presented in the paper "Oxide Gels, New Materials for Micro-Ionics" from *J. Livage* (France) who gave examples of systems which are good candidates for making "all-gel" derived micro-ionic devices.

On the whole, one can say that the goal of the meeting, of discussing the fundamental and applicationally oriented aspects of sol–gel processing with respect to material preparation, technology and structure/property relationships, was fulfilled, much to the credit of *H. Schmidt* from the Frauenhofer-Institut für Silicatforschung (Würzburg, FRG), who had composed this most interesting scientific program. This positive impression was not altered by the recognition that the great hopes for sol–gel technology have been somewhat overdone: today it is possible to make coatings by this method in considerable variety but until we succeed in making bulk materials on an industrial scale there will be much to do.

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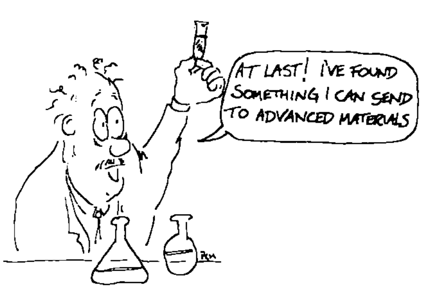

Durable Thermometer for Molten Metals

Conventional thermometers used to measure the temperature of, for example, molten steel are usually destroyed very quickly by the environment and provide data for only 1–3 seconds.

A new thermometer, developed by Nippon Steel and the Asahi Glass Co. has a functioning lifetime of over 40 hours. This increased durability is achieved by encasing the thermometer in a tube made from the advanced ceramic zirconium boride which has a melting point of 3060 °C allowing continuous measurement of temperatures up to 1600 °C.

Continuous monitoring of the temperature enables the effects of defect inclusions to be located precisely, processing abnormalities to be prevented and energy to be saved.

Further information is available from the Nippon Steel Corporation, Königsallee 30, Düsseldorf 4, FRG.

Laser Microscope for Surfaces

Zygo has introduced the Maxim 3D three-dimensional noncontact laser microscope for the measurement of surface structure. Its optical design allows it to measure coated carbon surfaces as easily as polished aluminum substrates.

Combining the capabilities of an optical microscope with the measurement resolution of phase-measuring interferometry, the Maxim 3D can perform vertical, lateral, angular and positional measurements to 6 Å vertical resolution and less than 0.5-micrometer lateral resolution. Three-dimensional measurements allow accurate analysis of surface defects, which can be located at low magnification, then measured at higher magnification by rotating the turret. Details from Zygo Corporation, Laurel Brook Road, Middlefield, Connecticut 06450, USA.

Field Emission Scanning Electron Microscope

International Scientific Instruments of California, USA have introduced a new field emission scanning electron microscope called the DS-130F which offers high resolution and large-sample handling capability. It is a dual stage microscope which provides nanometer resolution in its top stage and maintains 2 nm resolution in the bottom stage even with a large sample (up to 6 inches diameter).

The DS-130F operates in the 10^{-8} torr range and even at an electron beam energy of 1 kV provides resolution in the top and bottom stages of 4 and 10 nm respectively. Further features are a new condenser lens system, a high brightness thermal field emission gun and the high stability of the emission current, which makes tip flashing unnecessary.

More details are available from International Scientific Instruments, 1457 McCarthy Boulevard, Milpitas, California 95035, USA.