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## CERAMICS FROM SOLUTIONS: *sol-gel and fine powder technologies*

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During the last thirty years, techniques for making ceramic materials with well defined properties have increasingly relied on soluble salts and metal-organic precursors to meet exacting chemical purity, homogeneity and microstructural requirements. The resulting improvements in reactivity, compositional control and process flexibility have greatly extended our ability to make novel, utilitarian materials that are well beyond the limits believed to exist when only naturally occurring minerals were available. This symposium reviewed these developments and it gave an indication of the advances that will be made in the near future.

Sol-gel techniques permit mixing of multicomponent systems on a molecular level that decreases diffusion distances sufficiently to lower the maturing temperature by hundreds of degrees. Several speakers described how these complex structures are becoming understood in terms of the specifics of the metal-organic precursor and gelation history. The complex morphologies of these structures within a structure

of submicron dimensions is being revealed by electron optic methods.

Some applications of sol-gel techniques are well advanced. Extensive work on spherical nuclear fuel forms was presented and the variety of optical coatings available was described. A new class of cermet was presented that can be expected to possess unusual electrical properties. The results of a determination of the structure of vanadium pentoxide gels were presented. Antistatic coatings made from these gels have been used to coat over five million square meters of photographic film in France. Novel switching and display devices were also described that are based on vanadium and tungsten gels. A new gel-glass, high-level nuclear waste form was demonstrated to successfully immobilize reprocessing waste.

The preparation of silicon carbide fibers from silanes and silazanes was described as well as the carbothermic reduction of sol-gel derived precursors to make sinterable silicon carbide powders.

The ability to reproducibly make a wide range of ceramic materials

having well defined properties at significantly lower firing temperatures promises to revolutionize the ceramic industry during the coming decades. As volume increases the cost of most metal organics will decrease dramatically. When the overall economics are considered, sol-gel and fine particle ceramic technologies in combination with advanced heating methods such as microwave will displace many traditional ceramic processing methods.

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## NUCLEAR RADIATION *detector materials*

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This symposium, chaired by E. E. Haller of Lawrence Berkeley Laboratory, and by H. W. Kraner and W. A. Higinbotham of Brookhaven National Laboratory, provided a forum for nine invited papers and ten contributed papers addressing the status and problems of semiconductor and scintillator detector materials. Invited papers reviewed the growth and utilization of silicon, germanium, cadmium telluride and mercuric iodide semiconducting materials and sodium iodide, bismuth germanate and cadmium tungstate scintillators. Contributed papers discussed surface preparation of silicon, growth of high purity silicon, growth of and contact to mercuric iodide and the use of silicon photodiodes to sense NaI(Tl) scintillators.

Several clear developments and trends can be summarized: high purity germanium has completely displaced lithium-compensation of p-type material as a means of producing large sensitive detector volumes and prospects are good for the same application in silicon; bismuth germanate may also displace thallium-activated sodium iodide as the workhorse scintillator for many applications; mercuric iodide and cadmium telluride continue to mature as high-Z, room temperature semiconductor materials for many special applications, including X-ray spectrometry; and, finally, a large arc light sensitive silicon photodiode has demonstrated sufficient gain to prove useful as a solid state photomultiplier viewing NaI(Tl) light.

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