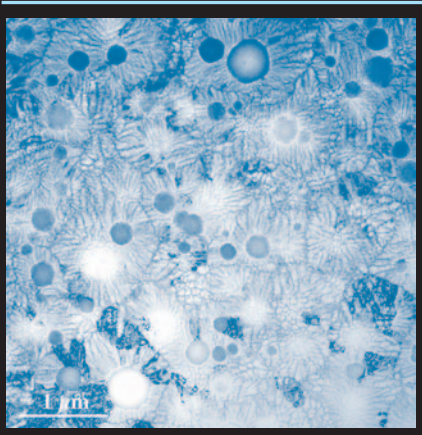
John W. Cahn

"Glass Formation from a Melt by a Nucleation and Growth Process"

John Werner Cahn obtained his B.S. in Chemistry from the University of Michigan and his Ph.D. in Physical Chemistry from the University of California, Berkeley. Dr. Cahn has been a Research Associate in the Metallurgy and Ceramics Department of the General Electric Research Laboratory; a Professor of Materials Science at the Massachusetts Institute of Technology; and a Center Scientist at the Center for Materials Science, National Bureau of Standards. He is currently a Senior National Institute of Standards and Technology (NIST) Fellow at the NIST Materials Science and Engineering Laboratory.

Dr. Cahn is a member of the National Academy of Sciences, the National Academy of Engineering, and the American Academy of Arts and Sciences. He is the author of some 250 published papers and has given 400 invited lectures. Among his many honors and awards, he has received the National Medal of Science and the S. B. Meyer Award from the American Ceramic Society. He formulated what are now known as the Cahn-Hilliard and Allen-Cahn equations and co-discovered quasicrystals.



There are two quite different views of metallic glasses. One is that a glass forms when an under-cooled melt becomes kinetically frozen into a well of an energy landscape. This mechanism is quite universal and in principle occurs for all melts if they can be cooled rapidly enough. Usually such glasses tolerate the same wide compositional variations of melts. In the other view the glass is an efficient high-density low-energy packing of atoms into an aperiodic isotropic structure. These glasses, which we dubbed q-glasses, are expected to be less tolerant of composition variations.

Evidence of the existence of a q-glass in Al-Fe-Si is presented. The glass is the first phase to form from the melt on cooling, and it forms by a nucleation and growth process. A detailed study of the formation of this glass from melts over a wide range of compositions reveals that the glass behaves like a stoichiometric compound, with a concentration near 15 a/o Fe, 20 a/o Si. There is an interface between the growing glass and the melt. When the melt differs from the concentration of the glass, we find partitioning at this interface and isotropic Mullins-Sekerka instabilities. With enough partitioning an icosahedral phase and/or complex intermetallic compounds, all with near-by compositions, form. Studies are under way to see if the glass and these other phases have similar local atomic packings.

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Bldg. 402 APS Auditorium • Argonne National Laboratory

APS Colloquium