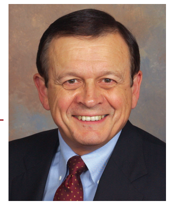
# From the Editor

## Nanoanalysis of Presolar Grains



When I see a polished section of an iron meteorite in a museum, I think how amazing it is that this piece of solar system debris survived its descent through the Earth's atmosphere to provide us with physical evidence of solar system formation. These meteorites, from the metallic core of a planet or asteroid that broke into fragments, contain phases originally analyzed for elemental composition decades ago using X-ray spectrometry in the electron probe microanalyzer (EPMA). As traditionally operated, the EPMA has a spatial resolution of analysis about 1 µm. However, recent research on certain types of meteorites requires much better spatial resolution.

There are three main types of meteorites: iron meteorites, stony meteorites, and stony-iron meteorites. Some stony meteorites, known as chondrites, are aggregates of early solar system components and occasionally contain small inclusions believed to have originated in debris that predates our solar system. These sub-µm-sized presolar grains have unusual isotope signatures in various elements, and some may contain nanometer-sized diamonds. These meteorites require "nanoanalysis," elemental analysis with a spatial resolution on the order of a few nanometers, about a hundred times better than that possible with the EPMA.

One method of achieving nanoanalysis is to produce an electron-transparent thin specimen of the meteorite and analyze it using X-ray spectrometry in a scanning transmission electron microscope (STEM-EDX); in this case the analytical spatial resolution can be 1–5 nm. Another method is to analyze a polished bulk specimen with Auger electron spectrometry (AES), where the primary electron beam can be focused to 5–10 nm and Auger electrons escape from within 3 nm of the surface, yielding an analytical resolution of about 10 nm. A third method known as atom probe tomography (APT) uses position-sensitive time-of-flight mass spectrometry to locate atoms in three dimensions with near-atomic resolution (<1 nm).

Finding presolar grains in a chondrite requires mass spectrometry: nano-scale secondary ion mass spectrometry (NanoSIMS) can identify grains with presolar isotope ratios for later AES analysis (see article in this issue by Floss), and APT can find grains with presolar isotope ratios as well as determine the compositions of phases within these grains (article by Lewis et al.). Finally, many site-specific analyses require specimen preparation to be done with a focused ion beam (FIB) milling instrument. A new mounting method simplifies specimen preparation for APT. This method has been applied to atomic-level analysis of an iron-nickel meteorite (article by Rout et al.).

Charles Lyman
Editor-in-Chief

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