## D3 Fulgurites in Litigation

*Christopher S. Palenik, PhD*, Microtrace, 790 Fletcher Drive, Ste 106, Elgin, IL 60123-4755*

The goal of this presentation is to illustrate the way in which a detailed microanalytical characterization of a relatively novel material, a fulgurite (amorphous silica produced by an energetic event), can provide detailed information about the origin of a fire.

This presentation will impact the forensic science community in two ways: (1) by illustrating the ways in which a novel material and creative analytical approach can provide critical scientific evidence in a forensic investigation; and, (2) by providing the community with a baseline of specific analytical data concerning the use of a fulgurite as forensic evidence.

The term fulgurite, which derives from the Latin *fulgur* (meaning "thunderbolt"), was originally intended to refer to amorphous silica produced by lightning strikes. Over time, this term has been more broadly applied throughout the literature to include amorphous silica (or related compositions) produced as a result of high-temperature or high-pressure events, which can also include anthropogenic activities.

A suspected fulgurite can be identified as such on the basis of specific analytical characteristics, which can include: morphology (a tube that can take on a dendritic shape); size (fulgurites typically range in volume from a cubic centimeter to a cubic meter); an amorphous structure; marginal zones that include transition grains in which a single grain can range from crystalline to amorphous; a hollow central channel that is often nearly circular; the presence of one or more silica high-temperature/high pressure-polymorphs (e.g., tridymide, cristobalite); gas inclusions; and flow lines captured in the quenched amorphous matrix. Such characteristics can be identified over a variety of length scales that range from field-level observations (centimeters to meters) to nanoscopic features (nanometers).

Once identified as a fulgurite, analytical characterization over this range of length scales can provide information about the mechanism by which it formed. In the context of a forensic fire investigation, the need may arise to determine whether a fire was started by a lightning strike or a power line discharge. While both events are the result of an electrical discharge of power, the magnitude and duration of such power transfers can vary dramatically. As such, certain features may be used to distinguish between the origin of this electrical discharge.

While analytical approaches will vary based upon the circumstances of a given case, the features that may be exploited to assist with such a determination include the composition of the fulgurite and surrounding host rock, the crystallography of the transition zone grains, the potential transfer of metal particles, and the macroscopical and microscopical morphology of the fulgurite. The mineral phase of certain grains as well as the microstructure (through analysis by Raman spectroscopy) can provide specific constraints on the pressure-temperature history of a sample. The above analytical data can be coupled with thermodynamic modeling of the possible scenarios. This combination of analyses and calculations can provide an independent means by which to elucidate the origin of the discharge that produced the fulgurite.

This approach may provide constraints on the cause and conditions of fulgurite formation, distinguish between natural and anthropogenic origins, and, in some cases, provide insight into the relative timing of fulgurite formation. This presentation will provide analytical and modeled data derived from the study of several fulgurite samples produced both anthropogenically and naturally, which will illustrate the ways in which fulgurites may be recognized and exploited in a forensic investigation. Ultimately, the application of such a seemingly esoteric material can provide pivotal information as to the cause of a fire during the course of a forensic investigation.

**Fulgurite, Amorphous Silica, Lightening**



*Presenting Author