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Techniques in Raman Imaging Analysis of Extraterrestrial Materials

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Raman spectroscopic imaging is an emerging new technique in the analysis of extraterrestrial materials such as meteorites, interplanetary dust (IDPs) and returned samples such as cometary material returned by NASA's Stardust probe. Raman spectroscopy is useful for mineral phase identification and can be sensitive to crystalline orientation and chemical composition. When presented in the form of images, this data produces maps of these parameters in spatial context with sub-micron resolution, without the necessity of coating or other sample preparation. While Raman spectroscopy is simple to use, producing the type of data described above in a meaningful fashion requires considerable experience. Several important considerations will be discussed here.

Since many extraterrestrial materials contain relatively volatile or otherwise fragile phases, laser power must be carefully controlled. More important than laser power is the laser power density experienced at the sample surface since this parameter is not dependent upon objective lens magnification or internal reflection losses. Methods for calculating laser power density at the focal plane and obtaining an upper limit for power density will be discussed. Imaging techniques such as phase mapping, composition gradient illustration and crystalline orientation mapping will also be described.

Of particular interest to extraterrestrial materials studies is the identification and characterization of carbonaceous materials. Raman spectroscopy is a particularly sensitive tool for this analysis, and methods for characterization of reduced and aliphatic carbonaceous matter will also be discussed.