Amorphous Silicates in Interplanetary Dust and Stardust Samples

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Astronomical observations show that amorphous silicate grains are ubiquitous throughout interstellar space and are major components of young stellar systems and comets [1]. Although amorphous silicates are rare in meteorites, they are abundant in anhydrous interplanetary dust particles (IDPs) and in the samples of comet Wild-2 returned by the Stardust spacecraft. Coordinated mineralogical and isotopic studies of amorphous silicates in these primitive materials show that most appear to have formed in the solar system, but some amorphous silicate grains are true 'stardust,' originating from stars that existed before our solar system formed [2]. The study of such materials provides detailed views on the lifecycles of dust in the galaxy and of the origins of the first solar system solids.

In cometary (anhydrous) IDPs, amorphous silicate grains are abundant and occur mostly in the form of GEMS (glass with embedded metal and sulfides). GEMS are submicrometer-sized rounded grains that consist of nanophase inclusions of FeNi metal, FeNi sulfides, and numerous trace phases in a Mg-Al-Fe-Si-rich glassy matrix. Coordinated transmission electron microscope and ion microprobe measurements show that, at most, only a few percent of GEMS are presolar (stardust), based on their oxygen isotopic compositions [2]. The vast majority of GEMS have chemical and oxygen isotopic compositions consistent with their formation in the early solar system.

While the analysis of Stardust cometary materials is still at an early stage, it appears that amorphous silicates were also common in comet Wild-2 [3]. The exact nature of these grains has not yet been determined, and is clouded by their variable thermal modification and fine scale mixing with aerogel during the capture process. Continued coordinated chemical and isotopic studies of Wild-2 materials are essential to clarifying the relationship of amorphous silicates in this comet to those observed in anhydrous IDPs, interstellar space, and young stellar objects.

Keywords: comets, amorphous silicates, GEMS, oxygen isotopes, Stardust.

References

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