Melting and quench experiment of iron sulfide fine particles at atmospheric entry

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Micrometeorites have the most abundant flux in current accumulation of planetary materials to the Earth. Composition and texture of micrometeorites are results of heating processes at atmospheric entry. Evaporation of meteoritic materials may have environmental effect at upper atmosphere. Troilite is typical FeS phase in chondritic meteorites. In this study, quick heating and cooling experiments of FeS reagent particles were carried out with a fine particles free falling apparatus with controlled gas flow (Isobe and Gondo, 2013). Starting material reagent is composed of troilite, mixture of Fe oxide and sulfide and iron metal. Oxygen fugacity was controlled to FMQ +1.5 log unit. Maximum temperature of the particles was higher than 1400˚C for approximately 0.5 seconds.

Run products with rounded shape and smooth surface show that the particles were completely melted. Chemical compositions of particles analyzed on cross sections are generally well homogenized from heterogeneous starting materials by complete melting. Molar ratios of Fe in melted regions are close to 0.5, while compositions of S and O are various. Varieties of S and O compositions show various degree of oxidation and evaporation of sulfur. Distribution of compositions of melted regions in Fe-S-O system is plotted in liquidus compositions of FeO and FeS saturated melt. Compositions of FeS melt in fine spherules are following Fe-S-O phase relations even in a few seconds. Evaporation of sulfur from meteoritic materials in atmospheric entry heating may depend on oxygen fugacity of the upper atmosphere. Sulfur supply from meteoritic materials to atmosphere may be limited on planets with oxygen-free atmosphere.

Keywords: troilite, micro meteorit, Fe-S-O system, magnetite, atmospheric heating

