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Identification of relict forsterite grains in forsterite-rich chondrules from the Mokoia CV3 carbonaceous chondrite

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Abstract

Magnesium-rich forsterite grains (>Fo_{98}) in FeO-poor chondrules show variations in cathodoluminescence (CL) intensity that are associated closely with variations in Al_2O_3 and TiO_2 contents. CL thus can be used to map the distribution of Al and Ti in individual grains. We describe several categories of CL distribution, including grains that are homogeneous, grains that are zoned continuously, grains that show oscillatory zoning, and grains that show a heterogeneous distribution of CL intensity. Heterogeneous CL intensity is interpreted as the result of disequilibrium growth from the chondrule melt. CL surveys of individual chondrules help to identify forsterite grains that are potentially relics in their host chondrules, i.e., grains that did not crystallize in situ from the chondrule melt. Several of these grains show minor-element variations that differ from the majority of melt-grown grains in their host chondrules: this observation supports the inference that they are relics. Little evidence exists for growth of individual grains in multiple brief heating episodes. Identification of the abundance of relict grains is important for determining the thermal histories of chondrules as well as the nature of the precursor assemblages from which they formed.

Keywords: chondrites, chondrules, forsterite, cathodoluminescence