American Mineralogist, Volume 82, pages 1001–1006, 1997

Sinoite (Si_2N_2O): Crystallization from EL chondrite impact melts

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Abstract

Sinoite (Si_2N_2O) was previously observed only in EL6 chondrites and recently modeled as having formed over geologic time scales at metamorphic temperatures of ~950 °C. I found several ~10–210 μm-sized subhedral and euhedral grains of twinned, optically zoned sinoite associated with euhedral enstatite and euhedral graphite within impact-melted portions of QUE94368, the first EL4 chondrite. The presence of sinoite within a type 4 chondrite mitigates against the metamorphic model of sinoite formation; it seems more likely that sinoite crystallized from a liquid. During impact melting of EL material, N_2 may have been released from lattice defects in sulfides whereupon it reacted with reduced Si dissolved in the metallic Fe-Ni melt and with fine-grained or molten silica derived from the silicate fraction of the EL assemblage. The N that formed the sinoite was derived from the silicate melt or from temporary, melt-filled cavities constructed from unmelted EL material in which the nitrogen fugacity may have reached ~40 to 130 bars (0.004 to 0.013 GPa). Sinoite in EL6 chondrites may have formed either metamorphically, as previously proposed, or by means of crystallization from an impact melt, as in QUE94368. In the latter case, sinoite-bearing EL6 chondrites would be annealed impact-melt breccias.