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# Insights into solar nebula formation of pyrrhotite from nanoscale disequilibrium phases produced by $H_2S$ sulfidation of Fe metal

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## Abstract

Lauretta (2005) produced sulfide in the laboratory by exposing canonical nebular metal analogs to $H_2S$ gas under temperatures and pressures relevant to the formation of the Solar System. The resulting reactions produced a suite of sulfides and nanophase materials not visible at the microprobe scale, but which we have now analyzed by TEM for comparison with interplanetary dust samples and comet Wild 2 samples returned by the Stardust mission. We find the unexpected result that disequilibrium formation favors pyrrhotite over troilite and also produces minority schreibersite, daubréelite, barringerite, taenite, oldhamite, and perryite at the metal-sulfide interface. TEM identification of nanophases and analysis of pyrrhotite superlattice reflections illuminate the formation pathway of disequilibrium sulfide. We discuss the conditions under which such disequilibrium can occur, and implications for formation of sulfide found in extraterrestrial materials.

**Keywords:** Pyrrhotite, troilite, sulfide, planetary science, TEM, XRD, $H_2S$, comet