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Wassonite: A new titanium monosulfide mineral in the Yamato 691 enstatite chondrite

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Abstract

Wassonite, ideally stoichiometric TiS, is a titanium monosulfide not previously observed in nature, that was discovered within the Yamato 691 EH3 enstatite chondrite. Twelve Ti-S phase grains were identified in a rare barred olivine (BO) chondrule; three of the grains were extracted by the focused ion beam technique. Because of the submicrometer size of the wassonite grains, it was not possible to determine conventional macroscopic properties. However, the chemical composition and crystal structure were well constrained by extensive quantitative energy-dispersive X-ray analysis and electron diffraction using transmission electron microscopy (TEM). The crystal system for wassonite is rhombohedral ($a = 3.42 \pm 0.07$, $c = 26.50 \pm 0.53$ Å) with space group: $R\bar{3}m$, cell volume: 268.4 ± 0.53 Å^3, $Z = 9$, density (calculated): 4.452 g/cm^3, empirical formula: $(Ti_{0.93},Fe_{0.06},Cr_{0.01})S$. The wassonite grains crystallized from the chondrule melt that was itself formed in the solar nebula, not on the parent asteroid. The other crystalline phases in the BO chondrule include forsterite, enstatite, troilite, metallic Fe-Ni, and osbornite (as well as the new Ti-S-bearing minerals and schollhornite) are highly reduced and indicate formation at low-oxygen fugacities.

Keywords: New mineral, wassonite, TiS, Antarctic meteorite, TEM, electron diffraction