DIRECT EVIDENCE FOR CONDENSATION OF MINERAL GRAINS IN CHONDRITIC METEORITES. H. Palme[1], A. Pack[2] and T. Berg[3], [1]Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, D-60325 Frankfurt/Main, Germany, e-mail: herbert.palme@uni-koeln.de; [2]Geowissenschaftliches Zentrum, Universität Göttingen, Goldschmidtstraße 1, D–37077 Göttingen, Germany; [3]Institut für Physik, Staudingerweg 7, D-55128 Mainz, Germany.

Introduction: The chemical composition of chondritic meteorites shows clear trends for volatility related fractionations. It is therefore often concluded that condensation processes played a major role in establishing the elemental abundances in chondritic meteorites. Yet, mineral grains that are unambiguous condensates from the solar nebula are extremely rare. Remelting on chondrule formation and various degrees of alteration on parent bodies have largely erased direct evidence for condesation. Here we list several candidates representing possible unaltered nebular condensates.

Metal particles: Zoned, FeNi-metal grains from CH- and CB-chondrites provide convincing evidence for a condensation origin [1]. It is, however, not clear if these grains formed in a gas of solar composition or if they condensed from a gas phase produced by evaporation of earlier formed solids.

The detection of enhanced Si and Cr contents in a metal grain from the Murchison meteorite expected from condensation calculations was taken to indicate a condensation origin [2]. Metal particles, rich in refractorty metals and compatible with a condensation origin were discovered by [3]. Recently precise measurements of the composition of 88 refractory metal rich nuggests with a size range from 100 nm to 1.2 μm were separated from acid resistant residues of the Murchison meteorite. The refractory metals are fractionated and closely followe trends predicted by condensation [4, 5]. A remarkable feature is the presence of hexagonal (hcp: Os, Ru), face centered cubic (fcc: Fe, Ni, Ir, Pt), and base centered cubic (bcc: W, Mo) metals in a single alloy exactly at the level expected from condensation calculations. The presence of the easily oxidizable elements W and Mo in the alloys indicates formation at reducing nebular conditions. Calculations indicate that particles could have formed by condensation. They were removed from equilibrium with the solar gas by being trapped in simultaneously condensing oxides. This suite of sub-micrometer particles are, so far, the best candidates for primary nebular condensates. Larger, frequently encountered, refractory metal particles in CAI are inevitably affected by exsolution, oxidation and sulfurization, leading to significant redistribution of the refractory metals into metal-, sulfide- and oxide-phases, e.g. [6, 7]. Thus, none of these particles can be considered a primary condensate.

Silicate Particles: Forsteritic olivine grains occur in all chondritic meteorites, even in the strongly oxidized Rumurutiites. They are good candidates for a condensation origin, either as single condensed mineral grains or as crystallization products of condensed liquids at solar nebula conditions [8, 9]. Forsteritic olivine grains have comparatively high CaO, reflecting high temperature formation, high and fractionated REE abundances, compatible with a nebular origin. The contents of FeO, NiO and CoO match the concentrations calculated for nebular condensates. The moderately volatile elements Na (<10 ppm) and Mn (<30 ppm) are extremly low, supporting a high temperature origin of the refractory forsterites. Oxygen isotopes are ^{16}O-rich and recently [10] noticed that a major fraction of Ti in these grains is Ti^{3+}, requiring very reducing conditions at their formation.

The identification of condensed forsteritic olivin grains is extremely important. They are the key for understanding bulk Mg/Si fractionation of chondritic meteorites.

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