MICROSTRUCTURAL AND MAGNETIC CHARACTERIZATION OF THE NWA-6259 IRON METEORITE.

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Introduction: NWA6259 is the second highest Ni content meteorite (42.6 wt%) and described as a strong permanent magnet iron meteorite [1,2]. We describe here the microstructure and magnetic properties of this meteorite. In addition we attempt to understand the relationship between the magnetic domain state and the microstructure of the meteorite and to provide guidance towards laboratory synthesis of the tetrataenite (Tt) phase.

Method: Optical Microscopy (OM), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) were used for microstructural characterization. Electron Probe Microanalysis (EPMA) and Analytical Electron Microscopy (AEM) were used for microchemical analysis and Electron Backscattered Diffraction (EBSD) was used to obtain the crystallographic orientation of the L10 FeNi phase in the NWA6259 meteorite. Vibrating sample magnetometry (VSM) was used to measure magnetization M as a function of applied field H and temperature T. M(H) was measured for different orientations of the field with respect to the crystalline axes. Magnetic force microscopy (MFM) was used to characterize the magnetic domains.

Results: The microstructure of the NWA6259 meteorite consists of a matrix of tetragonal L10 FeNi tetrataenite which was confirmed by electron and x-ray diffraction. Phosphide inclusions from several microns to nm in size are present in the matrix. The Ni content of the matrix is 44.5 wt % and Ni in the phosphides decreases from 46 to 35 wt.% as the phosphate size decreases. EBSD analysis of a NWA6259 specimen shows that the meteorite is highly textured, allowing determination of the magnetocrystalline anisotropy constant from the angular variation of M(H) relative to the easy magnetic axes. The uniaxial anisotropy constant is estimated as K_u = 1.1-1.3 x10^6 J/m³, corresponding to an anisotropy field H_e of about 2 Tesla. The coercivity-limited theoretical energy product of the Tt phase at room temperature is roughly (BH)_{max}=445 kJ/m³, approaching that found in today’s best magnet [3]. The microstructural and magnetic properties investigations add insight into the potential for Tt to be a permanent magnet.


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