NI- AND FE-POWDERS: GRAIN SIZE EFFECTS AND COMPOSITIONAL INFLUENCE ON THE SPECTRAL REFLECTANCE , H. Hoffmann, M. Berger, and G. Neukum; German Aerospace Research Establishment (DLR), Inst. for Optoelectronics, Planet. Remote Sensing Section, D-8031 Oberpfaffenhofen, FRG

Introduction: Metallic NiFe is one of the major mineral phases in the meteorites. Based on telescopic spectra and comparative laboratory studies, the M-type asteroids are considered to be mainly composed of metals (1, 2). Grain size effects on the spectral reflexion behaviour of metall have revealed special interest because of the optical alteration of ordinary chondrites and the composition and structure of S-type asteroidal surfaces (3, 4). We performed laboratory measurements of pure Ni- and Fe-powders of different grain sizes and their mixtures in order to investigate compositional and grain size effects on the spectral reflectance behaviour.

Samples: As samples we used six different, synthetically manufactured iron and nickel powders. The average grain size for each sample was determined under the microscope with 2.5, 5, and 132 μm for the Fe-samples and 1.6, 3, and 35 μm for the Ni-samples. The size differences are due the production process. Chemically, the samples are pure elements (> 99%). In order to increase the number of size fractions for each metall, mixtures in steps of 10% to 20% were produced. Compositional heterogeneity was achieved by mixing Fe and Ni at an increment of 5% to 10% (5).

Measurements: The measurements were performed with an IRIS Mark IV spectroradiometer in the wavelength range from 0.5-2.5 μm relative to halon. The phase angle was 30° at an emergence angle of 0°. Each sample was measured 8 times. After averaging, the spectra were corrected for halon.

Results: The spectra for the pure Ni- and Fe-powders are shown in Fig. 1 and 2, respectively. Both metalls exhibit a nearly featureless and reddish reflectance curve, which flattens towards the infrared. The measurements are in accordance with previous results of (6, 7, 8). The spectra of Ni show a stronger decrease in reflectance towards the blue compared with spectra of Fe. In contrast to the grain size effect for dielectric materials, the Ni- and Fe-powders become darker with decreasing grain size and the slope diminishes (Fig. 3). In the case of small grain sizes, both metalls have approximately the same level of reflectivity and a comparable continuum slope. Main differences in the spectral reflexion behaviour for the two elements can be observed for the latge grain size, where Ni with an average diameter of 35 μm is brighter than Fe with an average diameter of 132 μm.

The metall spectra can be approximated by a second order polynome of the form $X(\lambda) = a_0 + a_1\lambda + a_2\lambda^2$ where X is the reflectance at wavelength λ. The correlation coefficient R^2 for all the investigated samples is > 0.99. a_0 describes the overall albedo, a_1 the continuum slope, and a_2 the spectral contrast, i.e. the flattening towards the IR and the turn down towards the blue. The parameters a_0 and a_1 for all the Fe-samples and Fe-grain size mixtures are displayed in Fig. 4 and 5, respectively, against the corresponding average diameter. The parameters exhibit a logarithmic dependency. For grain sizes > ~60 μm, the average diameter can be determined with these two parameters. The same is true for Ni with grain sizes > ~18 μm. The scattering, which is stronger for the small grained fractions, can be attributed mainly to porosity effects due to variations of the skewness and curtosis of the mixtures. The higher the porosity, the darker is the sample.

A discrimination between Ni and Fe is only possible for mixtures of the large grained samples based on the increasing slope towards the blue with increasing Ni-content (Fig. 6). A quantitative assessment is possible based on the increasing a_0 and decreasing a_2 parameters. Grain size effects, however, dominate the spectral reflectance and conceal the compositional influence.

For comparison, polished slabs of the octaedrites Canyon Diablo and Toluca, the hexaedrite Tocopilla, and the ataxite Hoba were measured. Their spectral curves are comparable to the metall powders and can be also fitted with a second order polynome to an accuracy of > 0.98. The variations in the a_2 and a_0 parameters reflect the compositional and structural differences.

References:

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(8) *Feierberg, M. A. et al. (1982)* Astrophys. J. 257, 361-372

NI- AND FE-POWDERS: Hoffmann, H. et al.

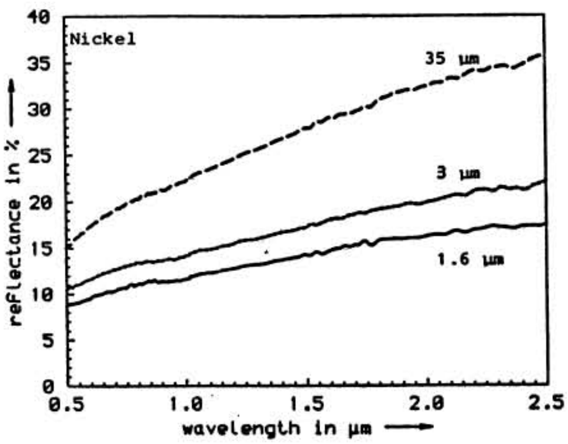

Figure 1. Spectra for the Ni-powders.

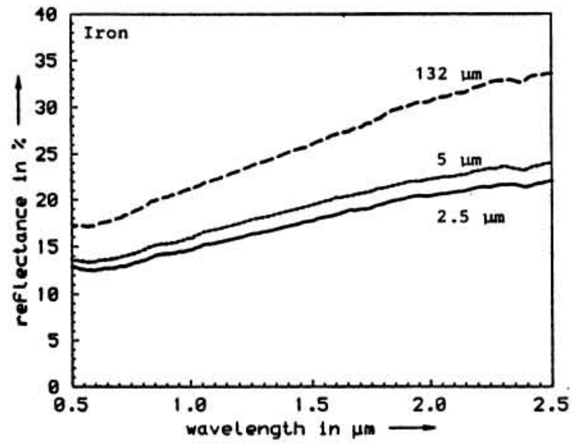

Figure 2. Spectra for the Fe-powders.

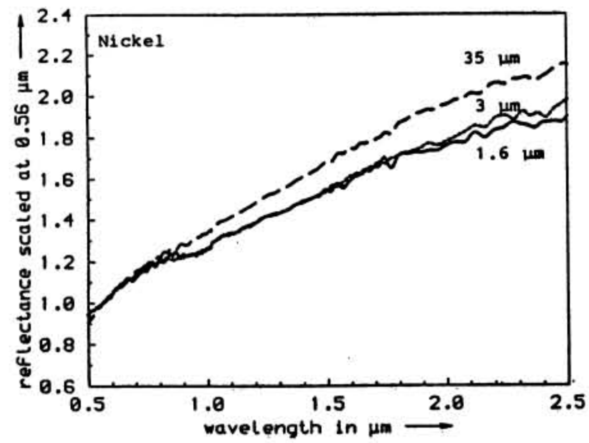

Figure 3. Spectra for the Ni-powders, scaled at 0.56 μm.

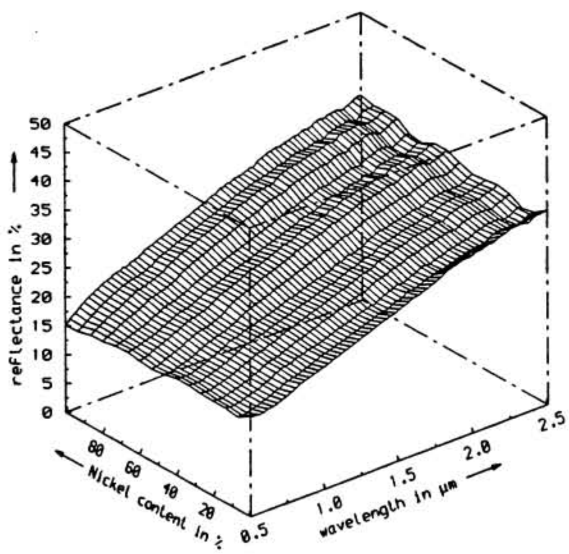

Figure 6. Mixture of the powders Fe (d = 132μm) and Ni (d = 35μm), interpolation by a bicubic spline.

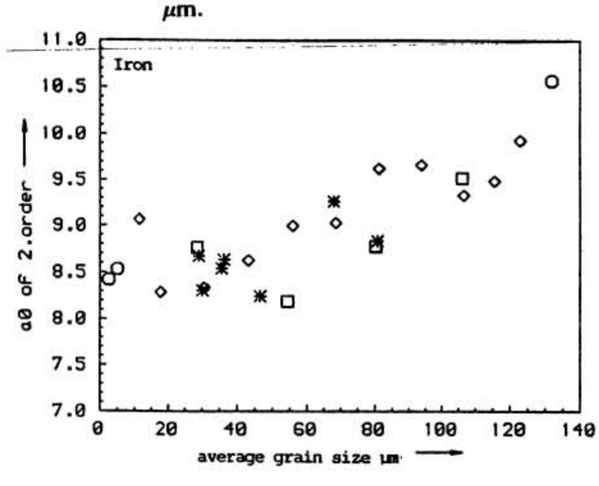

Figure 4. a_0 parameter versus average grain size for the Fe-samples and Fe-mixtures.

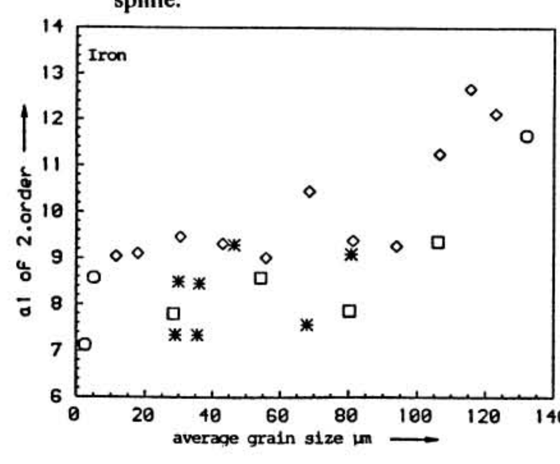

Figure 5. a parameter versus average grain size for the Fe-samples and Fe-mixtures.