

de grandeza) que foram denominados magnetostrição gigante. Dentre estas, as fases  $\text{Fe}_2\text{Tb}$  e  $\text{Fe}_2\text{Sm}$ , na forma de monocristais, apresentam as maiores magnetostrições (positiva e negativa respectivamente) à temperatura ambiente já conhecidas. Tais ligas tem amplas aplicações como transdutores eletromagnetomecânicos, substituindo cerâmicas piezoelétricas. Mais recentemente tais ligas tem sido estudadas na forma de filmes finos visando aplicações em microeletrônica. O processo de crescimento dos monocristais utilizado é o método Czochralski utilizando cadinhos de óxido de terra rara para evitar problemas de contaminação do líquido pelo material do cadinho. Resultados dos experimentos de crescimento e caracterização das fases  $\text{Fe}_2\text{Tb}$  e  $\text{Fe}_2\text{Sm}$ , e extensão para outras composições, incluindo elementos substituintes do ferro, como Ni, Co e Mn, e outras terras raras substituindo Tb e Sm, são apresentados.

work. synthetic and natural Ni enriched goethite samples were characterized by XRD, TEM, DTA-TGA and MS. Nine synthetic samples were prepared by ageing Ni-ferric hydroxides obtained from  $\text{Fe}^{3+}$  and  $\text{Ni}^{3+}$  nitrate solutions. Chemical analysis revealed that the maximum amount of Ni in crystalline phase was 3.2% mol. Synthetic samples showed better crystallinity than the natural goethite studied. The hyperfine field decreases, with some exceptions, with Ni incorporation for both samples sets. The other Mössbauer parameters do not vary significantly with nickel incorporation. The results indicate that the Ni is being incorporated in the structure of synthetic goethite, probably, in the octahedral substituting Fe. The same conclusion can be extended to the natural goethite samples. This work was supported by FAPESP

[13/05/99 - Painei - 14:00]

**GOETHITE WITH Ni:  
CHARACTERIZATION OF SYNTHETIC  
AND NATURAL SAMPLES INCLUDING  
MÖSSBAUER SPECTROSCOPY**

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Goethite is one of the most common mineral phases present in soils around the world. The crystal structure of goethite favors the incorporation of ionic species of metals other than iron. Gossans, goethite concentrations over sulfide ores, can also accumulate elements like Ni, Cu, Zn and Pb. The ways of foreign metals are incorporated into these natural concentrations of goethite is still unknown. Natural goethite is usually fine grained and poorly crystalline turning the characterization by X-ray diffraction (XRD) as well as by infrared and Mössbauer Spectroscopy (MS) difficult. The study of synthetic samples used as reference against which the natural samples are compared, is a manner to overcome those difficulties. Numerous investigations have been made with natural and synthetic goethite associated with different ions. MS were made only to study Al and Mn goethite synthetic samples. The behavior of elements which can contaminate soils and waters, plus the availability of natural goethite samples with high Ni content, turns the study of the association of this element with goethite of interest. In the present

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**MAGNETISM OF HEAVY FERMION  
 $\text{Ce}(\text{Co}_{1-x}\text{Fe}_x)\text{Ge}_3$  SEEN BY A LOCAL PROBE**

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While the isostructural  $\text{CeFeGe}_3$  is a moderate heavy fermion (HF) compound which do not show any magnetic phase transition above  $0.5\text{K}$ ,  $\text{CeCoGe}_3$  is also a HF exhibiting a high value of the linear coefficient  $\gamma$  in the specific heat but has a complex phase diagram with two magnetic transitions at  $\sim 21$  and  $\sim 18\text{K}$  in the absence of a magnetic field. The upper ordering temperature is believed to be a transition from the paramagnetic state to a  $c$ -axis ferrimagnetic state, which in turn transform to a collinear antiferromagnetic state at  $\sim 18\text{K}$ . Since the unit cell volume decreases from  $\text{CeFeGe}_3$  to  $\text{CeCoGe}_3$  (although only by 1.5%), the changes in the band structure (band filling) are probably responsible for such a drastic change in the ground state. Single phase polycrystalline samples of  $\text{Ce}(\text{Co}_{1-x}\text{Fe}_x)\text{Ge}_3$  samples were prepared by conventional arc-melting in partial argon atmosphere with subsequent annealing. Here we report about the  $^{57}\text{Fe}$  Mössbauer measurements of  $\text{Ce}(\text{Co}_{1-x}\text{Fe}_x)\text{Ge}_3$  ( $x = 0.01$ , and  $0.02$ ). The room temperature spectra show a unique quadrupole doublet which is attributed to Fe in the  $\text{CeCoGe}_3$  structure. At  $4.2\text{K}$  the Mössbauer spectra show magnetic hyperfine ( $hf$ ) field at the  $^{57}\text{Fe}$  nucleus in both compounds. The magnetic  $hf$  field at the  $^{57}\text{Fe}$  nucleus is a pure dipolar or a transferred  $hf$  field via RKKY interaction, resulting from the ordered neighboring Ce moments. In order to study the spin structure of these compounds, Mössbauer measurements in function of temperature were performed. The analysis of low temperature spectra shown diffe-