Independent tuning of particle diameter and interparticle spacing in Ni nanoparticle systems

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Macroscopic properties of ferromagnetic-metal nanoparticle systems are strongly affected by two microstructural parameters; the diameter of constituent particles \( d \) and their spacing \( r \). Therefore, these parameters must be fine-tuned in order to design and realize a system for a specific purpose or application, e.g., ultra-high density magnetic recording media. Nevertheless, independent and precise modification of the \( d \) and \( r \) at the level of several nanometers still remains a challenge. In this contribution, the independent tuning of the \( d \) and \( r \) in ferromagnetic Ni nanoparticle systems has been reported.

Ni nanoparticles were chemically embedded in polymer films called polyimide by applying a surface modification technique. The structure of the films was characterized by transmission electron microscopy (TEM). The TEM observation showed that the thermal decomposition of the polyimide matrices brings about a decrease in the spacing \( r \) among Ni nanoparticles with an almost constant diameter \( d \). Ferromagnetic resonance (FMR) in the films was investigated. The FMR studies clearly indicate that we have succeeded in controlling the magnetic dipolar interaction among Ni nanoparticles via independent tuning of \( d \) and \( r \). The present study allows us to open a new way to realize tailor-made nanostructured magnetic materials.