Magnetic properties and up-conversion of $NaYF_4$ nanoparticles doped with rare earth elements, for bio-medical imaging and treatment.

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Bioimaging techniques are typically based on fluorophores UV light excitation. This approach has several disadvantages, such as a small tissue penetration and undesirable sample autofluorescence. The sensitivity and resolution of imaging can be improved by using two-photon process and excitation by near-infrared light (NIR) within the biological tissues optical transmission window (700–1000 nm). Up-conversion based methods offer increase of optical contrast, deeper light penetration and minimized autofluorescence and light scattering. Furthermore, NIR does not cause radiation damage to cellular functions and structures. Nanoparticles doped with rare earth (RE) metal ions exhibit paramagnetic properties that allow to use them in magnetic resonance imaging (MRI). Optical properties of RE doped nanoparticles can be used in fluorescent markers (VIS) and in photodynamic cancer therapy.

In this study we present results of magnetic measurements and up-conversion performed in magnetic field at various temperatures. $NaYF_4$ nanoparticles with diameter of 33±14 nm were doped with Er^{3+}, Yb^{3+} and Gd^{3+}. Magnetic properties were measured using SQUID magnetometry. Measurements were performed in temperatures from 2.0 K to 350.0 K and magnetic fields up to 7.0 T. Magnetization of the measured particles shows linear increase with the dopant concentration and also can be reasonably described by a proper theoretical model. Up-conversion measurements were performed in temperatures ranging from 4.0 K up to room temperature and magnetic fields up to 9.0 T. Samples were excited with infrared 980 nm laser.

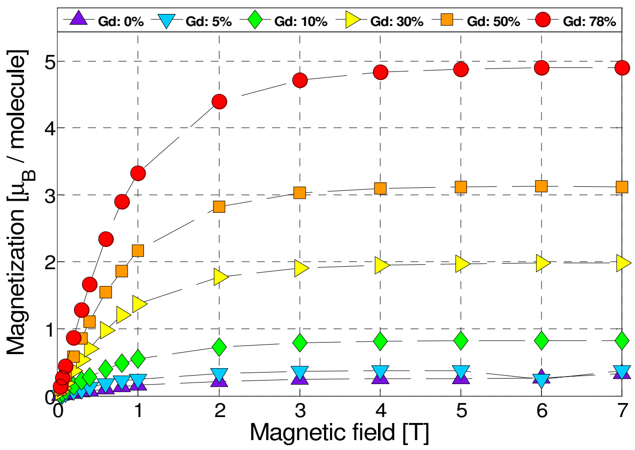

Figure 1. Magnetization as a function of magnetic field; Temperature T = 2.0 K

Results show that up-conversion process is temperature-sensitive and is only weakly disturbed by external magnetic fields up to 9.0 T. That combined with observed paramagnetism of up-converting nanoparticles opens a possibility to use magnetic field for example as an additional position controller for multifunctional nanoparticles with theranostic properties.