CS-04. Easy synthesis and characterization of $\gamma$-Fe$_{2}$O$_{3}$ nanoparticles for biomedical applications. S. An$^1$, I. Shim$^1$ and C. Kim$^1$. Department of Physics, Kookmin University, Sungbuk-gu, Seoul, South Korea

Easy synthesis of $\gamma$-Fe$_{2}$O$_{3}$ nanoparticles have been synthesized by sol-gel method using ONLY iron nitrate (Fe(NO$_{3}$)$_{3}$9H$_{2}$O) under un Ar/H$_{2}$(5 %) bal-
ance gas atmosphere. The powders present average particle size of 7, 10, 13
nm with narrow size distribution for samples as-obtained and annealed at
150, 175 and 200 °C, respectively. Magnetic and structural properties of the
powders were characterized with a Mössbauer spectroscopy, vibrating sam-
ple magnetometer, x-ray diffraction, and transmission electron microscopy
(TEM). At room temperature, 10 nm particles were partially superparamag-
netic. The Mossbauer spectrum for the 7 nm samples at room temperature
displays superparamagnetic behavior as demonstrated by the single quadru-
pole doublet with zero hyperfine fields. Superparamagnetic particles display
no sextet in Mossbauer spectra at temperatures above blocking temperature
($T_B = 165$ K for 7 nm sample), which depends on the particle volume,
anisotropy and so on. Note that the single quadrupole doublet represents the
fraction of small particles in which long range magnetic ordering is absent.
The hyperfine parameters for the sample are isomer shift $\delta = 0.34$ mm/s and
quadrupole splitting $E_Q = 0.92$ mm/s, respectively. These values are typical of
Fe$^{3+}$ ions in the high-spin state, and we suggest that this sample should be a
$\gamma$-Fe$_2$O$_3$. The spectrum for the 13 nm samples at room temperature shows a
general sextet shape indicating ferrimagnetic behaviors. For this sample, the
room temperature spectrum was fitted using two magnetic components of
hyperfine fields $H_{hf} = 490$ and 460 kOe, isomer shifts $\delta = 0.31$ and 0.39 mm/s
corresponding to Fe$^{3+}$ ions at sites A and Fe$^{3+}$ ions at site B, respectively, with
nearly null quadrupole splitting. It is considered that 7 nm samples are avail-
able for biomedical applications such as hyperthermia and drug delivery sys-
tem as a magnetic fluid carrier because it has spherical shape, narrow particle
distribution, chemical stability, and superparamagnetic behavior.