

Magnetic Properties of Magnetic Particles

Bangs Laboratories offers multiple lines of superparamagnetic microparticles with different chemical and physical properties to address a wide range of applications in the life sciences, e.g. as solid supports for cell separations, biomolecule isolations and purifications, immunoassays, and suspension arrays, as labels for MR imaging studies, etc. A few examples of properties that vary between the different magnetic particle types are listed below:

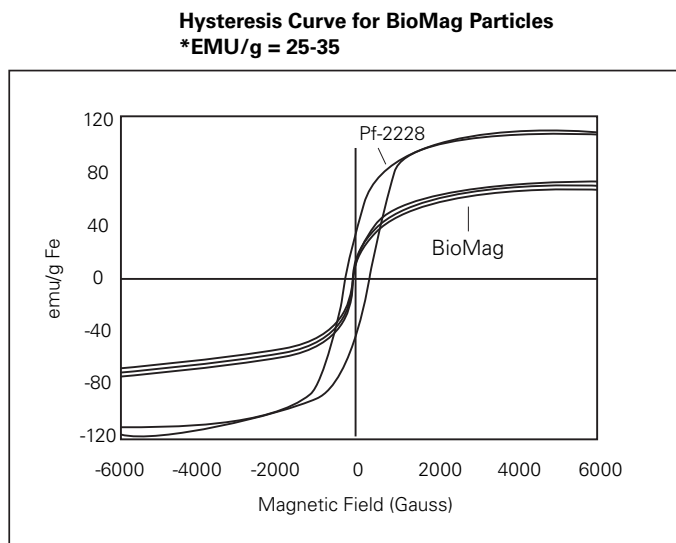
- size (diameter and uniformity)
- shape (spherical, semi-spheroid, irregular-shaped)
- density
- composition and synthesis methods (polymer-based, non-polymeric)
- surface properties (exposed iron oxide, hydrophobicity/hydrophilicity, etc.)
- functional properties and coatings available
- autofluorescence and background signal in chemiluminescence-based assays
- iron oxide content and magnetic properties

Bangs does not routinely measure the iron oxide content or magnetic properties of our superparamagnetic particle offerings. However, representative data is available for a few particle lines. Table 1 lists approximate percent magnetite values for Bangs' magnetic particle lines. Representative magnetization data for BioMag®, COMPEL™, magnetic classical (MC) / magnetic encapsulated (ME), and ProMag® particle lines may be found in Fig. 1 – 6.

Table 1. Approximate percent magnetite values/ranges for representative ProMag®, BioMag®, COMPEL™, magnetic classical, and magnetic encapsulated particles.

Catalog Code/s	Description	Percent Magnetite (%)
PM*1N	ProMag® 1 Series	~26.5%
PM*3N	ProMag® 3 Series	~18%
PM*3HP	ProMag® 3 HP	~17%
MC03F	~0.9µm magnetic classical	~62%
ME03F	~0.9µm magnetic encapsulated	~46%
ME04F	~1.6µm magnetic encapsulated	~42.5%
BM***, BP***, BMM**	BioMag®, BioMag®Plus, BioMag® Maxi	>90%
UMC3N, UMC3F	~3µm COMPEL™	~10-12.5%
UMC3N, UMC3F	~6µm COMPEL™	~5.5-6.5%
UMC4N, UMC4F	~8µm COMPEL™	~3-3.6%

Figure 1. Hysteresis curve for representative BioMag® particles (magnetization value of 25-35 emu/g (measured at 1000 gauss)).



*Electromagnetic Units

Figure 2. Hysteresis curve for representative 6µm COMPEL™ magnetic beads (magnetization value of 2.80 emu/g).

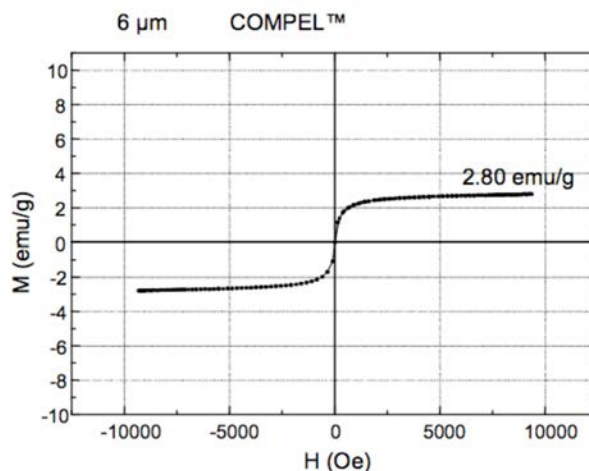
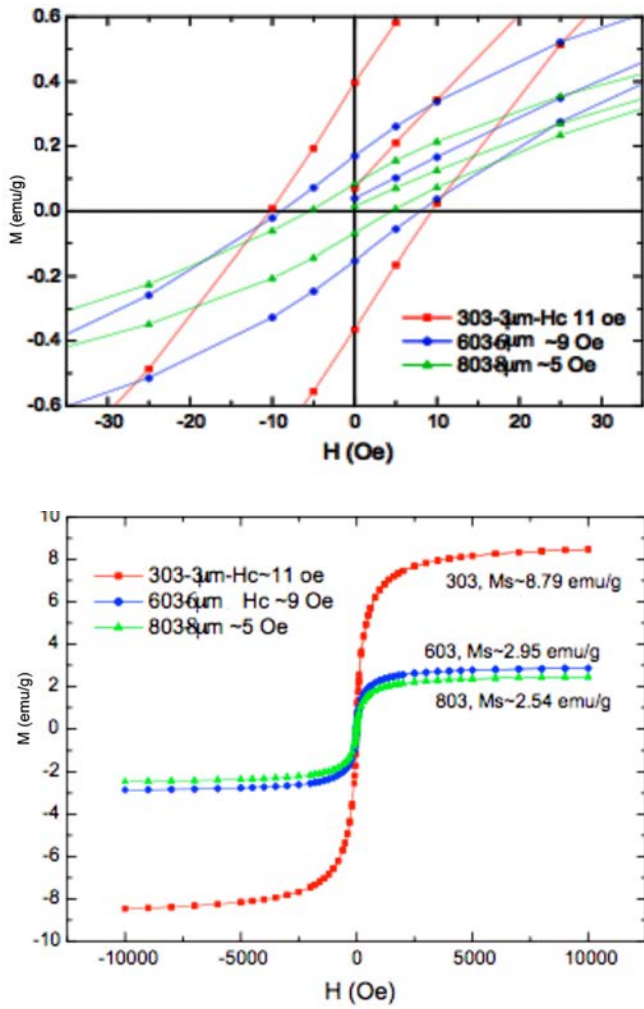
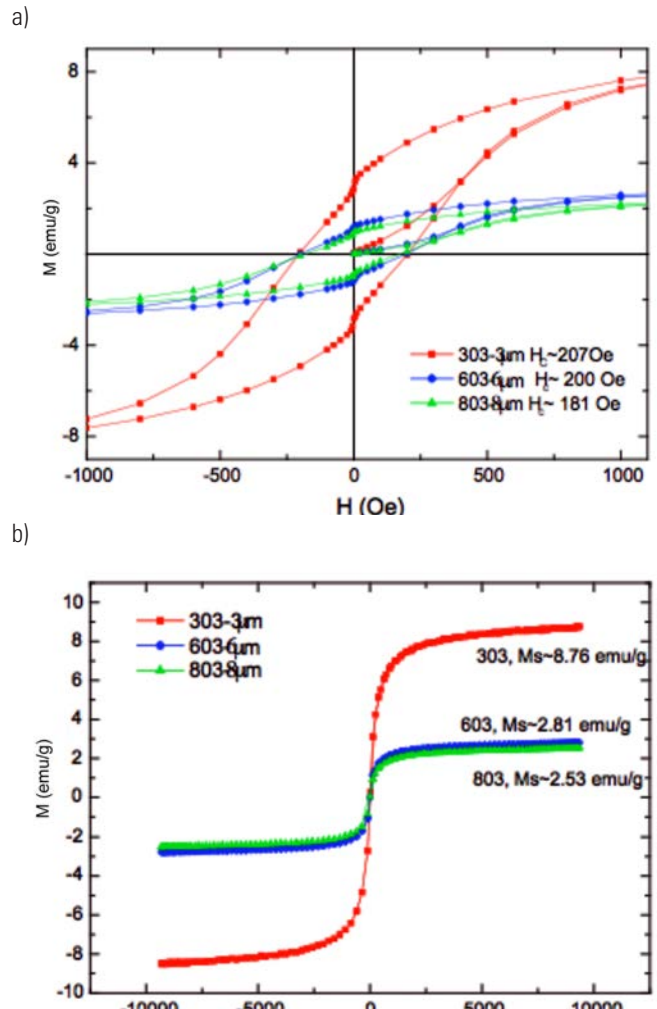


Figure 3. SQUID magnetometry magnetization data for representative 3µm, 6µm, and 8µm COMPEL™ magnetic beads at 300K (room temperature).



COMPEL SAMPLE	Saturation magnetization (emu/g)	Initial susceptibility (emu/gOe)
303-3µm	8.79	0.0389
603-6µm	2.95	0.0189
803-8µm	2.54	0.0149

Figure 4. a) SQUID magnetometry magnetization data for representative COMPEL™ magnetic beads at 5K. b) VSM mode data for representative 3µm, 6µm, and 8µm COMPEL™ magnetic beads. c) SQUID and VSM data summary for representative 3µm, 6µm, and 8µm COMPEL™ magnetic beads.



COMPEL sample	SQUID data				Saturation magnetization from the VSM data (emu/g)
	Ms (emu/g)		Coercivity (Oe)		
	300k	5k	300k	5k	
303-3µm	8.79	9.84	~11	~207	8.76
303-6µm	2.95	3.26	~9	~200	2.81
603-8µm	2.54	2.81	~5	~181	2.53

Figure 5. Hysteresis curve for representative magnetic classical and magnetic encapsulated particles (orange diamonds, 60% magnetite).

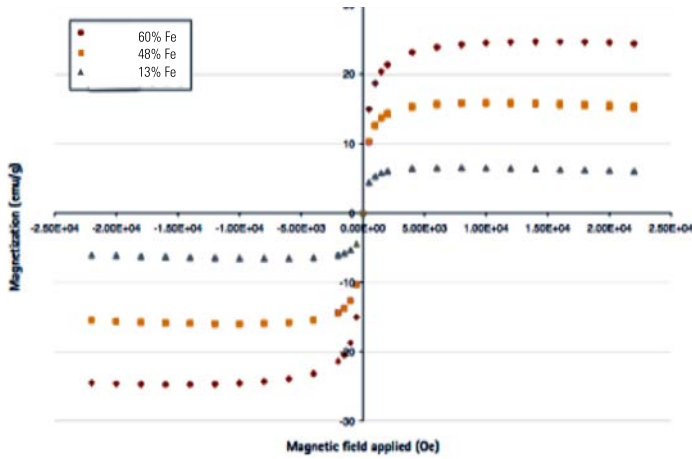


Figure 6. Hysteresis curve for representative ProMag® 3 Series particles (squares, magnetic saturation value of 27.6 emu/g). Graph taken from: Hu J, Xie M, Wen C-Y, Zhang Z-L, Xie H-Y, Liu A-A, Chen Y-Y, Zhou S-M, Pang D-W. (2011) A multicomponent recognition and separation system established via fluorescent, magnetic, dualencoded multifunctional bioprobes. *Biomaterials*.;32:1177-84.

