

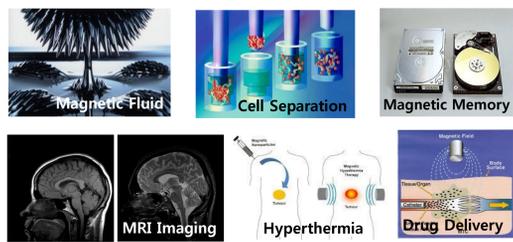
Effect of Pressure on the Synthesis of Magnetite Nanoparticles Using a High Pressure Homogenizer

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1. Introduction

Applications of Magnetite Nanoparticles

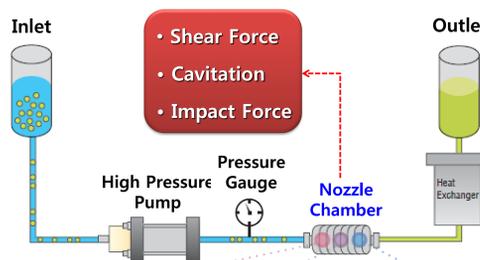


Magnetite nanoparticles have received intensive interest in recent years due to their potential applications in various fields, such as in magnetic memory devices, magnetic fluids, magnetic refrigeration, magnetic resonance imaging and targeting drug delivery systems

Objectives of This Study

- Synthesis of uniform magnetite nanoparticles using a high pressure homogenizer without any dispersing agent.
- Control of the size of the magnetite nanoparticles.
- Synthesis of superparamagnetic magnetite nanoparticles

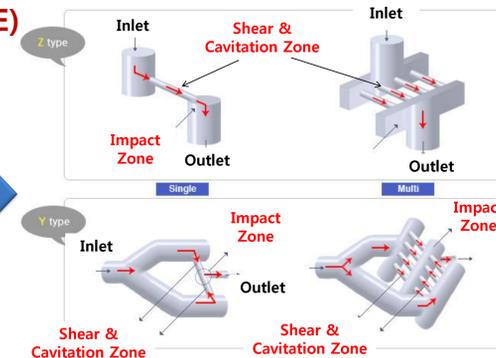
High Pressure Homogenizer (HPH, Nano Disperser, ILSHIN AUTOCLAVE)



Fluid Velocity (Sound Speed: 340 m/s)

Pressure (bar)	500	1000	1500	2000	2500
Fluid velocity (m/sec)	313	442	542	626	700

Nozzle Chamber

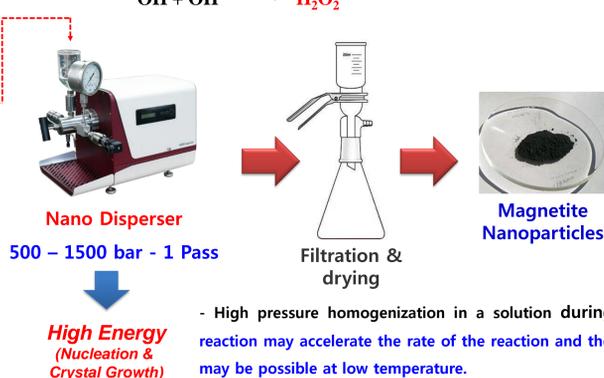
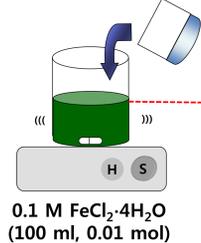


- Cavitation**
 - the formation, growth, and implosive collapse of bubbles in a fluid
- Cavitation Collapse**
 - intense local heating (~5000 K)
 - high pressures (~1000 atm)
 - enormous heating and cooling rates (10⁹ K/sec)
- Advantages**
 - Highly dispersion by high energy, Short process time

2. Experimental & Results

Experimental

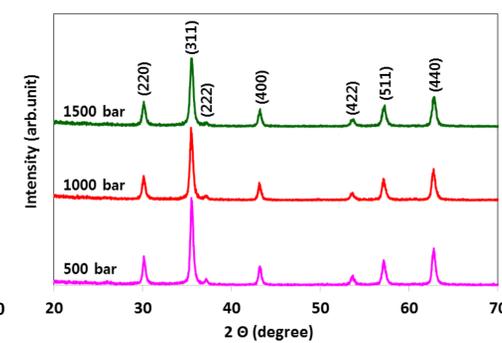
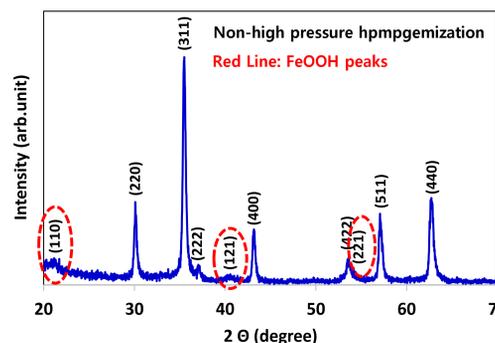
0.85 M NaOH (30 ml, 0.0255 mol)



- * Optimum conditions:
- Reaction Temp.: R.T
 - Stirring Time: 5 min

- High pressure homogenization in a solution during the chemical reaction may accelerate the rate of the reaction and the crystallization may be possible at low temperature.

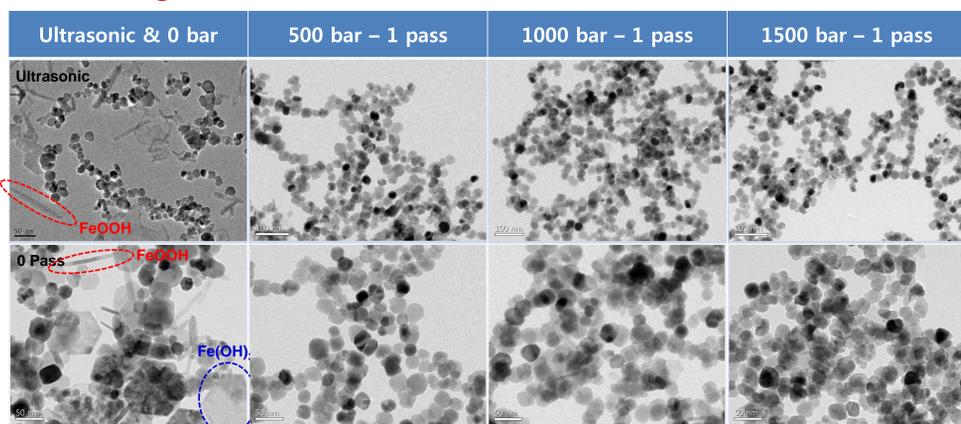
XRD Patterns



- The XRD pattern of the 0 pass sample showed diffraction peaks at 2θ = 21.1°, 40.3° and 53.8° from the FeOOH.
- All the peaks of 500 ~ 1500 bar samples were matched to the inverse spinel Fe₃O₄.

3. Results & Discussion

TEM Images



- The particles synthesized through the ultrasonic method and 0 pass sample are spherical, through square and rod shapes could also be observed.
- Spherical magnetite nanoparticles were obtained for 500 to 1500 bar.

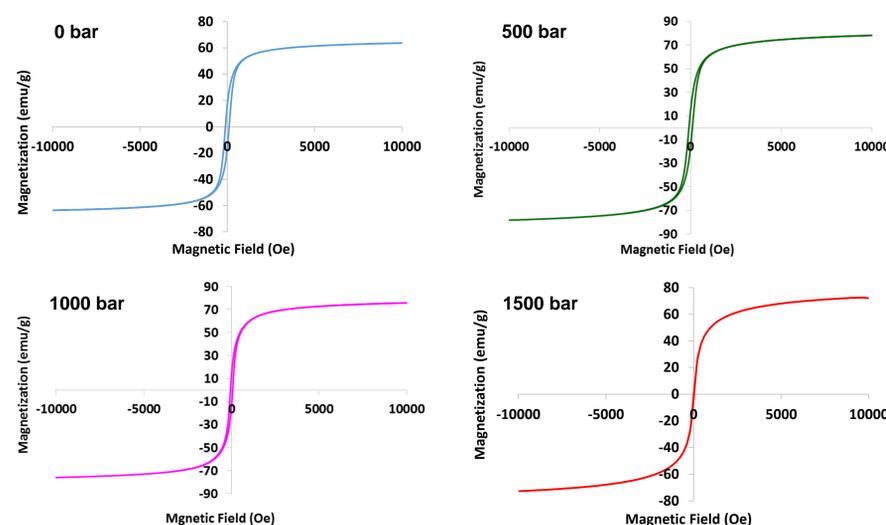
Average particle sizes and magnetic properties of the prepared magnetite nanoparticles

	Average Particle Size (nm)		Magnetic Property ^(b)			
	XRD ^(a)	TEM	Magnetization (emu/g)	Coercive (Oe)	Retentivity (emy/g)	
0 bar	26	-	64	125	17	FeOOH Fe(OH) _x Fe ₃ O ₄
500 bar	24	24	78	87	15	Cubic Spinel
1000 bar	22	22	75	61	13	Cubic Spinel
1500 bar	21	20	72	-	-	Cubic Spinel

^a The particle size was calculated from the values of FWHM at the diffraction peak of 35.4° for Fe₃O₄.

^b Magnetic properties were determined by VSM.

VSM



4. Conclusion

- We have synthesized uniform magnetite nanoparticles using the high pressure homogenizer without dispersing agent and oxidant.
- The X-ray diffraction patterns showed that all the samples had the inverse spinel structure of magnetite nanoparticles.
- The average particle size decreased with the pressure of high pressure homogenizer
- The VSM measurements revealed superparamagnetism of the nanoparticles for 1 pass at 1500 bar.
- The uniform size, narrow distributions and superparamagnetism of these magnetite nanoparticles demonstrated their suitability for use as an MRI contrast agent, as magnetic fluids, and for targeting drug delivery systems.