References

[1] J. J. Mock, D. R. Smith, and S. Schultz, "Local refractive index dependence of plasmon resonance spectra," *Nano Lett.*, pp. 485–491, 2003.

[2] A. J. Haes and R. P. Van Duyne, "A nanoscale optical biosensor: Sensitivity and selectivity of an approach based on the localized surface plasmon resonance spectroscopy of triangular silver nanoparticles," *J. Am. Chem. Soc.*, vol. 124, no. 35, pp. 10596–10604, 2002.

[3] G. Lavorato *et al.*, "Exchange bias and surface effects in bimagnetic CoO-core / Co 0 . 5 Ni 0 . 5 Fe 2 O 4 -shell nanoparticles," *Phys. Rev. B*, vol. 94, no. 054432, pp. 1–9, 2016.

[4] M. Takafuji, S. Ide, H. Ihara, and Z. Xu, "Preparation of Poly (1-vinylimidazole) -Grafted Magnetic Nanoparticles and Their Application for Removal of Metal Ions," no. 4, pp. 1977–1983, 2004.

[5] R. Thomas, I. Park, and Y. Y. Jeong, "Magnetic Iron Oxide Nanoparticles for Multimodal Imaging and Therapy of Cancer," pp. 15910–15930, 2013.

[6] R. Lv *et al.*, "A yolk-like multifunctional platform for multimodal imaging and synergistic therapy triggered by a single near-infrared light," *ACS Nano*, vol. 9, no. 2, pp. 1630–1647, 2015.

[7] Q. A. Pankhurst, J. Connolly, J. S. K., and J. Dobson, "Applications of magnetic nanoparticles in biomedicine," *J. Phys. D-Applied Phys.*, vol. 36, no. 13, pp. R167–R181, 2003.

[8] K. S. Lee and M. A. El-Sayed, "Gold and silver nanoparticles in sensing and imaging: Sensitivity of plasmon response to size, shape, and metal composition," *J. Phys. Chem. B*, vol. 110, no. 39, pp. 19220–19225, 2006.

[9] L. C. Mimun, G. Ajithkumar, C. Rightsell, B. W. Langloss, M. J. Therien, and D. K. Sardar, "Synthesis and characterization of Na(Gd0.5Lu0.5)F4:Nd3þ,a core-shell free multifunctional contrast agent," *J. Alloys Compd.*, vol. 695, pp. 280–285, 2017.

[10] Y. Liu and Z. Tang, "Multifunctional Nanoparticle @ MOF Core – Shell Nanostructures," pp. 5819–5825, 2013.

[11] B. Liu *et al.*, "Multifunctional $NaYF_4$:Yb, Er@mSiO_2 @Fe_3O_4 -PEG nanoparticles for UCL/MR bioimaging and magnetically targeted drug delivery," *Nanoscale*, vol. 7, no. 5, pp. 1839–1848, 2015.

[12] Z. Zhou *et al.*, "Biomaterials Iron / iron oxide core / shell nanoparticles for magnetic targeting MRI and near-infrared photothermal therapy," *Biomaterials*, vol. 35, no. 26, pp. 7470–7478, 2014.

[13] W. Baaziz *et al.*, "Magnetic Iron Oxide Nanoparticles : Reproducible Tuning of the Size and Nanosized-Dependent Composition , Defects , and Spin Canting," 2014.

[14] D. Shi, M. E. Sadat, A. W. Dunn, and D. B. Mast, "Photo-fluorescent and magnetic properties of iron oxide nanoparticles for biomedical applications," *Nanoscale*, vol. 7, no. 18, pp. 8209–8232, 2015.

[15] J. Mohapatra, A. Mitra, H. Tyagi, D. Bahadur, and M. Aslam, "Iron oxide nanorods as high-performance magnetic resonance imaging contrast agents," *Nanoscale*, vol. 7, no. 20, pp. 9174–9184, 2015.

[16] T. Liu *et al.*, "Iron Oxide Decorated MoS 2 Nanosheets with Double PEGylation for Chelator-Free Radiolabeling and Multimodal Imaging Guided Photothermal Therapy," *ACS Nano*, vol. 9, no. 1, pp. 950–960, 2015.

[17] S. B. Goldhaber, "Trace element risk assessment: Essentiality vs. toxicity," *Regul. Toxicol. Pharmacol.*, vol. 38, no. 2, pp. 232–242, 2003.

[18] D. Bobo, K. J. Robinson, J. Islam, K. J. Thurecht, S. R. Corrie, and S. R. Corrie, "Nanoparticle-Based Medicines : A Review of FDA-Approved Materials and Clinical Trials to Date," *Pharm. Res.*, vol. 33, pp. 2373–2387, 2016.

[19] Y. K. Gun and C. Á. Nanomedicine, "Multifunctional Magnetic-fluorescent Nanocomposites for Biomedical Applications," pp. 87–104, 2008.

[20] L. Wang, W. Tang, Z. Zhen, H. Chen, J. Xie, and Q. Zhao, "Improving detection speci fi city of iron oxide nanoparticles (IONPs) using the SWIFT sequence with long T 2 suppression," *Magn. Reson. Imaging*, vol. 32, no. 6, pp. 671–678, 2014.

[21] H. Jang *et al.*, "In vivo magnetic resonance and fluorescence dual imaging of tumor sites by using dye-doped silica-coated iron oxide nanoparticles," *J. Nanoparticle Res.*, vol. 18, no. 2, pp. 1–11, 2016.

[22] D. Shi *et al.*, "Conjugation of quantum dots and Fe 3 O 4 on carbon nanotubes for medical diagnosis and treatment," pp. 2009–2011, 2009.

[23] R. K. Sharma, S. Dutta, S. Sharma, R. Zboril, R. S. Varma, and M. B. Gawande, "Fe3O4(iron oxide)-supported nanocatalysts: Synthesis, characterization and applications in coupling reactions," *Green Chem.*, vol. 18, no. 11, pp. 3184–3209, 2016.

[24] D. K. Kim, Y. Zhang, J. Kehr, T. Klason, B. Bjelke, and M. Muhammed, "Characterization and MRI study of surfactant-coated superparamagnetic nanoparticles administered into the rat brain," vol. 225, pp. 256–261, 2001.

[25] S. Santra, R. Tapec, N. Theodoropoulou, J. Dobson, A. Hebard, and W. Tan, "Synthesis and Characterization of Silica-Coated Iron Oxide Nanoparticles in Microemulsion : The Effect of Nonionic Surfactants," *Langmuir*, vol. 17, pp. 2900–2906, 2001.

[26] P. A. Dresco, V. S. Zaitsev, R. J. Gambino, and B. Chu, "Preparation and Properties of Magnetite and Polymer Magnetite Nanoparticles," no. 12, pp. 1945–1951, 1999.

[27] D. K. Kim, Y. Zhang, W. Voit, K. V Rao, and M. Muhammed, "Synthesis and characterization of surfactant-coated superparamagnetic monodispersed iron oxide nanoparticles," *J. Magn. Magn. Mater.*, vol. 225, pp. 30–36, 2001.

[28] M. Mahmoudi and M. A. Shokrgozar, "Multifunctional stable fluorescent magnetic nanoparticles," *Chem. Commun.*, vol. 48, no. 33, p. 3957, 2012.

[29] S. Santra, C. Kaittanis, J. Grimm, and J. M. Perez, "Drug / Dye-Loaded , Multifunctional Iron Oxide Nanoparticles for Combined Targeted Cancer Therapy and Dual Optical / Magnetic Resonance Imaging," *Small*, vol. 5, no. 16, pp. 1862–1868, 2009.

[30] K. D. Wegner and N. Hildebrandt, "Quantum dots: bright and versatile in vitro and in vivo fluorescence imaging biosensors," *Chem. Soc. Rev.*, vol. 44, no. 14, pp. 4792–4834, 2015.

[31] K. Yang *et al.*, "Multimodal Imaging Guided Photothermal Therapy using Functionalized Graphene Nanosheets Anchored with Magnetic Nanoparticles," *Adv. Mater.*, vol. 24, pp. 1868–1872, 2012.

[32] P. K. Jain, K. S. Lee, I. H. El-sayed, and M. A. El-sayed, "Calculated Absorption and Scattering Properties of Gold Nanoparticles of Different Size , Shape , and Composition : Applications in Biological Imaging and Biomedicine," *J. Phys. Chem. B*, vol. 110, pp. 7238–7248, 2006.

[33] A. Hanini, A. Schmitt, K. Kacem, F. Chau, S. Ammar, and J. Gavard, "Evaluation of iron oxide nanoparticle biocompatibility.," *Int. J. Nanomedicine*, vol. 6, pp. 787–794, 2011.

[34] C. Eggeling, J. Widengren, R. Rigler, and C. A. M. Seidel, "Photobleaching of

Fluorescent Dyes under Conditions Used for Single-Molecule Detection: Evidence of Two-Step Photolysis," vol. 70, no. 13, pp. 2651–2659, 1998.
[35] D. Huo *et al.*, "Fabrication of AuAg core-shell NPs as enhanced CT contrast agents with broad antibacterial properties," *Colloids Surfaces B Biointerfaces*, vol. 117, pp. 29–35, 2014.
[36] G. A. O. Jinhao, G. U. Hongwei, and X. U. Bing, "Multifunctional magnetic nanoparticles: design, synthesis, and biomedical applications," *Acc. Chem. Res.*, vol. 42, no. 8, pp. 1097–1107, 2009.
[37] J. Kim, Y. Piao, and T. Hyeon, "Multifunctional nanostructured materials for multimodal imaging, and simultaneous imaging and therapy," *Chem. Soc. Rev.*, vol. 38, no. 2, pp. 372–390, 2009.
[38] V. S. R. Harrison, C. E. Carney, K. W. Macrenaris, E. A. Waters, and T. J. Meade, "Multimeric Near IR − MR Contrast Agent for Multimodal In Vivo Imaging," *J. Am. Chem. Soc.*, vol. 137, pp. 9108–9116, 2015.
[39] S. Narayanan, B. N. Sathy, U. Mony, M. Koyakutty, S. V. Nair, and D. Menon, "Biocompatible magnetite/gold nanohybrid contrast agents via green chemistry for MRI and CT bioimaging," *ACS Appl. Mater. Interfaces*, vol. 4, no. 1, pp. 251–260, 2012.
[40] J. Lim, S. P. Yeap, H. X. Che, and S. C. Low, "Characterization of magnetic nanoparticle by dynamic light scattering," *Nanoscale Res. Lett.*, vol. 8, no. 1, pp. 1–14, 2013.
[41] H. Shokrollahi, "Contrast agents for MRI," *Mater. Sci. Eng. C*, vol. 33, no. 8, pp. 4485–4497, 2013.
[42] S. Smitha *et al.*, "Fluorescent Superparamagnetic Iron Oxide Core–Shell Nanoprobes for Multimodal Cellular Imaging," *Mater. Express*, vol. 2, no. 4, pp. 265–274, 2012.
[43] R. Tietze *et al.*, "Efficient drug-delivery using magnetic nanoparticles - biodistribution and therapeutic effects in tumour bearing rabbits," *Nanomedicine Nanotechnology, Biol. Med.*, vol. 9, no. 7, pp. 961–971, 2013.
[44] A. Tiwari, N. C. Verma, A. Singh, C. K. Nandi, and J. K. Randhawa, "Carbon coated core–shell multifunctional fluorescent SPIONs," *Nanoscale*, vol. 10, pp. 10389–10394, 2018.
[45] E. Teston *et al.*, "Design, properties, and in vivo behavior of superparamagnetic persistent luminescence nanohybrids," *Small*, vol. 11, no. 22, pp. 2696–2704, 2015.
[46] H. Chen *et al.*, "Magnetic and optical properties of multifunctional core–shell radioluminescence nanoparticles," *J. Mater. Chem.*, vol. 22, no. 25, p. 12802, 2012.
[47] D. Sarkar, "Probing the interaction of a globular protein with a small fluorescent probe in the presence of silver nanoparticles: spectroscopic characterization of its domain specific association and dissociation," *RSC Adv.*, vol. 3, no. 46, p. 24389, 2013.
[48] H. Wong, H. L. W. Chan, and J. H. Hao, "Magnetic and luminescent properties of multifunctional GdF 3 : Eu 3 + nanoparticles," *Appl. Phys. Lett.*, vol. 95, p. 022512, 2009.
[49] D. Caruntu, G. Caruntu, and C. J. O'Connor, "Magnetic properties of variable-sized Fe_3O_4 nanoparticles synthesized from non-aqueous homogeneous solutions of polyols," *J. Phys. D. Appl. Phys.*, vol. 40, no. 19, pp. 5801–5809, 2007.
[50] J. Mohapatra, A. Mitra, H. Tyagi, D. Bahadur, and M. Aslam, "Iron oxide nanorods as high-performance magnetic resonance imaging contrast agents.," *Nanoscale*,

vol. 7, no. 20, pp. 9174–84, 2015.
[51] C. P. Bean and J. D. Livingston, "Superparamagnetism," *J. Appl. Phys.*, vol. 30, no. S120, 1959.
[52] M. Yang, L. Gao, K. Liu, C. Luo, and Y. Wang, "Talanta nanoparticles as T1 and T2 dual mode MRI contrast agent," *Talanta*, vol. 131, pp. 661–665, 2015.
[53] H. Bin Na, I. C. Song, and T. Hyeon, "Inorganic nanoparticles for MRI contrast agents," *Adv. Mater.*, vol. 21, no. 21, pp. 2133–2148, 2009.
[54] S. Srivastava *et al.*, "Magnetic-nanoparticle-doped carbogenic nanocomposite: An effective magnetic resonance/fluorescence multimodal imaging probe," *Small*, vol. 8, no. 7, pp. 1099–1109, 2012.
[55] X. Mao, J. Xu, and H. Cui, "Functional Nanoparticles for Magnetic Resonance Imaging," *Wiley Interdiscip Rev Nanomed Nanobiotechnol.*, vol. 8, no. 6, pp. 814–841, 2016.
[56] J. J. W. Lagendijk, "Hyperthermia treatment planning.," *Phys. Med. Biol.*, vol. 45, pp. R61–R76, 2000.
[57] S. A. Shah, D. B. Reeves, R. M. Ferguson, J. B. Weaver, and K. M. Krishnan, "Mixed Brownian alignment and N??el rotations in superparamagnetic iron oxide nanoparticle suspensions driven by an ac field," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 92, no. 9, pp. 1–11, 2015.
[58] A. G. Roca, B. Wiese, J. Timmis, G. Vallejo-Fernandez, and K. O'Grady, "Effect of frequency and field amplitude in magnetic hyperthermia," *IEEE Trans. Magn.*, vol. 48, no. 11, pp. 4054–4057, 2012.
[59] A. Muela *et al.*, "Optimal Parameters for Hyperthermia Treatment Using Biomineralized Magnetite Nanoparticles: Theoretical and Experimental Approach," *J. Phys. Chem. C*, vol. 120, no. 42, pp. 24437–24448, 2016.
[60] J. Huang *et al.*, "Effects of Nanoparticle Size on Cellular Uptake and Liver MRI with PVP-Coated Iron Oxide Nanoparticles," *ACS Nano*, vol. 4, no. 12, pp. 7151–7160, 2010.
[61] G. Mie, "Beitra¨ge zur Optik tru¨ber Medien speziell kolloidaler Goldlo¨ sungen," *Ann. Phys.*, vol. IV, no. 3, pp. 377–445, 1908.
[62] C. Noguez, "Surface Plasmons on Metal Nanoparticles : The Influence of Shape and Physical," *J Phys Chem C*, vol. 111, pp. 3806–3819, 2007.
[63] O. A. Yeshchenko, I. M. Dmitruk, A. A. Alexeenko, M. Y. Losytskyy, A. V. Kotko, and A. O. Pinchuk, "Size-dependent surface-plasmon-enhanced photoluminescence from silver nanoparticles embedded in silica," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 79, no. 23, pp. 1–8, 2009.
[64] M. G. Blaber, M. D. Arnold, and M. J. Ford, "Search for the Ideal Plasmonic Nanoshell: The Effects of Surface Scattering and Alternatives to Gold and Silver," *J. Phys. Chem. C*, vol. 113, no. 8, pp. 3041–3045, 2009.
[65] T. Wriedt, "The Mie Theory: A Review," in *The Mie Theory, Springer Series in Optical Sciences*, vol. 169, 2012, pp. 53–71.
[66] C. Mätzler, "MATLAB Functions for Mie Scattering and Absorption," *IAP Res Rep*, vol. 2002-08, no. July 2002, pp. 1139–1151, 2002.
[67] Prashant K. Jain, Kyeong Seok Lee, Ivan H. El-Sayed, and Mostafa A. El-Sayed, "Calculated Absorption and Scattering Properties of Gold Nanoparticles of Different Size, Shape, and Composition: Applications in Biological Imaging and Biomedicine," *J. Phys. Chem. B*, vol. 110, pp. 7238–7248, 2006.
[68] P. K. Jain, X. Huang, I. H. El-Sayed, and M. A. El-Sayed, "Review of some interesting surface plasmon resonance-enhanced properties of noble metal nanoparticles and their applications to biosystems," *Plasmonics*, vol. 2, no. 3, pp.

107–118, 2007.

[69] F. Tam, C. Moran, and N. Halas, "Geometrical parameters controlling sensitivity of nanoshell plasmon resonances to changes in dielectric environment," *J. Phys. Chem. B*, vol. 108, no. 45, pp. 17290–17294, 2004.

[70] Y. Sun and Y. Xia, "Gold and silver nanoparticles: A class of chromophores with colors tunable in the range from 400 to 750 nm," *Analyst*, vol. 128, no. 6, p. 686, 2003.

[71] D. D. Evanoff and G. Chumanov, "Synthesis and optical properties of silver nanoparticles and arrays," *ChemPhysChem*, vol. 6, pp. 1221–1231, 2005.

[72] D. L. Dexter, "A Theory of Sensitized Luminescence in Solids," *J. Chem. Phys.*, vol. 21, no. 5, pp. 836–850, 1953.

[73] G. T. Boyd, Z. H. Yu, and Y. R. Shen, "Photoinduced luminescence from the noble metals and its enhancement on roughened surfaces," *Phys. Rev. B*, vol. 33, no. 12, pp. 7923–7936, 1986.

[74] Z. Xu, Y. Hou, and S. Sun, "Magnetic Core / Shell Fe 3 O 4 / Au and Fe 3 O 4 / Au / Ag Nanoparticles with Tunable Plasmonic Properties," no. iii, pp. 8698–8699, 2007.

[75] Y. Lin and C. L. Haynes, "Synthesis and Characterization of Biocompatible and Size-Tunable Multifunctional Porous Silica Nanoparticles," no. 16, pp. 3979–3986, 2009.

[76] M. E. Sadat *et al.*, "Photoluminescence and photothermal effect of Fe3O4 nanoparticles for medical imaging and therapy," *Appl. Phys. Lett.*, vol. 105, no. 9, p. 091903, 2014.

[77] B. D. Cullity and C. D. Graham, *Introduction to Magnetic Materials*, vol. Second Edi. 2009.

[78] R. C. O'Handley, *Modern Magnetic Materials*, vol. 414–415. 2000.

[79] W. Nolting and A. Ramkanth, *Quantum Theory of Magnetism*. 2009.

[80] P. V. Hendriksen, S. Linderoth, and P. -A.lindgard, "Magnetic properties of Heisenberg clusters," *J. Phys. Condens. Matter*, vol. 5, pp. 5675–5684, 1993.

[81] S. Bedanta and W. Kleemann, "Supermagnetism," *J. Phys. D-Applied Phys.*, vol. 42, p. 013001 (1-28), 2009.

[82] K. Nadeem, H. Krenn, T. Traussnig, R. Würschum, D. V. Szabó, and I. Letofsky-Papst, "Effect of dipolar and exchange interactions on magnetic blocking of maghemite nanoparticles," *J. Magn. Magn. Mater.*, vol. 323, no. 15, pp. 1998–2004, 2011.

[83] V. Dimitriadis, D. Kechrakos, O. Chubykalo-Fesenko, and V. Tsiantos, "Shape-dependent exchange bias effect in magnetic nanoparticles with core-shell morphology," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 92, no. 6, pp. 1–6, 2015.

[84] G. F. Goya, T. S. Berquó, F. C. Fonseca, and M. P. Morales, "Static and dynamic magnetic properties of spherical magnetite nanoparticles," *J. Appl. Phys.*, vol. 94, no. 5, pp. 3520–3528, 2003.

[85] J. L. Dormann, D. Fiorani, and E. Tronc, *Magnetic Relaxation in Fine-particle systems*, vol. XCVIII. 1997.

[86] E. Skoropata, R. D. Desautels, C. Chi, H. Ouyang, J. W. Freeland, and J. Van Lierop, "Magnetism of iron oxide based core-shell nanoparticles from interface mixing with enhanced spin-orbit coupling," *Phys. Rev. B*, vol. 89, no. 024410, pp. 1–9, 2014.

[87] T. D. Shen, R. B. Schwarz, and J. D. Thompson, "Paramagnetism , superparamagnetism , and spin-glass behavior in bulk amorphous Pd – Ni – Fe –

P alloys," *J. Appl. Phys.*, vol. 85, no. 8, pp. 4110–4119, 1999.
[88] T. Ising and I. Hamiltonian, "The Curie – Weiss Model," 2017.
[89] S. Mørup, C. Frandsen, and M. F. Hansen, *Magnetic properties of nanoparticles*, vol. 2. 2017.
[90] B. M. Moskowitz, "http://www.irm.umn.edu/hg2m/hg2m_d/hg2m_d.html.," *Environmental Magnetism Workshop, the Institute for Rock Magnetism*. .
[91] W. F. Brown, "Thermal fluctuations of a single-domain particle," *Phys. Rev.*, vol. 130, no. 5, pp. 1677–1686, 1963.
[92] K. Mandel, F. Hutter, C. Gellermann, and G. Sextl, "Stabilisation effects of superparamagnetic nanoparticles on clustering in nanocomposite microparticles and on magnetic behaviour," *J. Magn. Magn. Mater.*, vol. 331, pp. 269–275, 2013.
[93] P.A. Joy, P.S. Anil Kumar and S. K. Date, "The relationship between field-cooled and zero-field-cooled susceptibilities of some ordered magnetic systems. Journal of Physics: Condensed Matter, 10 (48), 11049–11054, 1998..
[94] D. Fiorani *et al.*, "Collective magnetic state in nanoparticles systems," *J. Magn. Magn. Mater.*, vol. 197, pp. 143–147, 1999.
[95] J. L. Dormann *et al.*, "From pure superparamagnetic regime to glass collective state of magnetic moments in -Fe O nanoparticle assemblies," vol. 187, pp. 139–144, 1998.
[96] R. Skomski, *Simple Models of Magnetism, Oxford University Press, Oxford*. 2008.
[97] J. Chen, C. Sorensen, K. Klabunde, G. Hadjipanayis, E. Devlin, and a. Kostikas, "Size-dependent magnetic properties of MnFe2O4 fine particles synthesized by coprecipitation," *Phys. Rev. B*, vol. 54, no. 13, pp. 9288–9296, 1996.
[98] S. H. Kilcoyne and R. Cywinski, "Ferritin: a model superparamagnet," *J. Magn. Magn. Mater.*, vol. 140–144, pp. 1466–1467, 1995.
[99] L. León Félix *et al.*, "Structural and magnetic properties of core-shell Au/Fe3O4 nanoparticles," *Sci. Rep.*, vol. 7, no. 41732, pp. 1–8, 2017.
[100] P. W. Anderson, "Antiferromagnetism. Theory of Suyerexchange," *Phys. Rev.*, vol. 79, no. 1934, 1950.
[101] C. A. Cardoso *et al.*, "Spin glass behavior in RuSr2Gd1.5Ce0.5Cu2O10À‽ ," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 67, p. 020407(R) 1-4, 2003.
[102] J. A. Mydosh, *Spin Glasses: An Experimental Introduction*. 1993.
[103] W. Zhang *et al.*, "The effect of surface and interface on Neel transition temperature of low-dimensional antiferromagnetic materials The effect of surface and interface on Neel transition temperature of low-dimensional antiferromagnetic materials," vol. 117228, pp. 0–8, 2015.
[104] L. Néel, "Thermoremanent magnetization of fine powders," *Rev. Mod. Phys.*, vol. 25, no. 1, pp. 293–295, 1953.
[105] R. O. R. V. Chamberlin, George Mozurkewich, "Time Decay of the Remanent Magnetization in Spin-Glasses," *Phys. Rev. Lett.*, vol. 52, no. 10, pp. 867–870, 1984.
[106] T. E. Torres *et al.*, "Validity of the Neel-Arrhenius model for highly anisotropic CoxFe3-xO4," *J. Appl. Phys.*, vol. 118, p. 183902, 2015.
[107] E. P. Shtrikman, S and Wohlfarth, "The theory of the Vogel-Fulcher Law of Spin Glasses," *Phys. Lett.*, vol. 85 A, no. 8, pp. 467–470, 1981.
[108] L. C. Sampaio *et al.*, "Power-law relaxation decay in two-dimensional arrays of magnetic dots interacting by long-range dipole-dipole interactions," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 64, no. 184440, pp. 1–7, 2001.
[109] R. K. Rakshit and R. C. Budhani, "Magnetic relaxation and superparamagnetism of non-interacting disordered CoPt nanoparticles," *J. Phys. D. Appl. Phys.*, vol. 39,

pp. 1743–1748, 2006.

[110] S. D. Tiwari and K. P. Rajeev, “Signatures of spin-glass freezing in NiO nanoparticles,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 72, no. 104433, pp. 1–9, 2005.

[111] L. Shlyk, S. Strobel, B. Farmer, L. E. De Long, and R. Niewa, “Coexistence of ferromagnetism and unconventional spin-glass freezing in the site-disordered kagome ferrite SrSn2Fe4O11,” *Phys. Rev. B*, vol. 97, no. 054426, pp. 1–11, 2018.

[112] S. Sun *et al.*, “Controlled Synthesis of MFe 2 O 4 (M = Mn , Fe , Co , Ni and Zn) Nanoparticles,” *J.Am.Chem.Soc.*, vol. 126, pp. 273–279, 2004.

[113] A. B. Chin and I. I. Yaacob, “Synthesis and characterization of magnetic iron oxide nanoparticles via w / o microemulsion and Massart ’ s procedure,” vol. 191, pp. 235–237, 2007.

[114] E. Iglesias-silva, J. L. Vilas-vilela, M. A. López-quintela, J. Rivas, M. Rodríguez, and L. M. León, “Synthesis of gold-coated iron oxide nanoparticles,” *NOC*, vol. 356, no. 25–27, pp. 1233–1235, 2010.

[115] R. He, X. You, J. Shao, F. Gao, and B. Pan, “Core / shell fluorescent magnetic silica-coated composite nanoparticles for bioconjugation,” vol. 18, 2007.

[116] J. Kuli, V. Herynek, M. Mary, and J. Koktan, “Journal of Magnetism and Magnetic Materials Titania-coated manganite nanoparticles : Synthesis of the shell , characterization and MRI properties,” no. June, 2016.

[117] F. Zeb, A. R. Qureshi, K. Nadeem, M. Mumtaz, and H. Krenn, “Surface effects in uncoated and amorphous SiO2 coated cobalt ferrite nanoparticles,” *J. Non. Cryst. Solids*, vol. 435, pp. 69–75, 2016.

[118] S. T. Selvan, T. Thatt, Y. Tan, D. K. Yi, and N. R. Jana, “Functional and Multifunctional Nanoparticles for Bioimaging and Biosensing,” vol. 26, no. 2, pp. 11631–11641, 2010.

[119] G. J. Stasiuk *et al.*, “Cell-Permeable Ln (III) Chelate- Functionalized InP Quantum Dots As Multimodal Imaging Agents,” *ACS Nano*, vol. 5, no. 10, pp. 8193–8201, 2011.

[120] T. Maldiney, B. T. Doan, D. Alloyeau, M. Bessodes, D. Scherman, and C. Richard, “Gadolinium-doped persistent nanophosphors as versatile tool for multimodal in vivo imaging,” *Adv. Funct. Mater.*, vol. 25, no. 2, pp. 331–338, 2015.

[121] R. M. Cornell and U. Schwertmann, *The Iron Oxides: Structure, Properties, Reactions, Occurences and Uses, 2nd Edition*. 2003.

[122] M. Lin *et al.*, “Hydrothermal Synthesis of Octadecahedral Hematite (α -Fe 2 O 3) Nanoparticles : An Epitaxial Growth from Goethite (α -FeOOH),” *J. Phys. Chem. C*, vol. 118, pp. 10903–10910, 2014.

[123] M. Sorescu, R. A. Brand, D. Mihaila-Tarabasanu, and L. Diamandescu, “The crucial role of particle morphology in the magnetic properties of haematite,” *J. Appl. Phys.*, vol. 85, no. 8, pp. 5546–5548, 1999.

[124] A. Bee, R. Massart, and S. Neveu, “Synthesis of very fine maghemite particles,” *J. Magn. Magn. Mater.*, vol. 149, pp. 6–9, 1995.

[125] W. F. J. Fontijn, P. J. van der Zaag, L. F. Feiner, R. Metselaar, and M. A. C. Devillers, “A consistent interpretation of the magneto-optical spectra of spinel type ferrites (invited),” *J. Appl. Phys.*, vol. 85, no. 8, pp. 5100–5105, 1999.

[126] E. Verwey, “Electronic Conduction of Magnetite (Fe_3O_4) and its Transition Point at Low Temperatures,” *Nature, vol.* **144,** 327–328, 1939.

[127] Y.W. Jun, Y.M. Huh, J.S. Choi, J.H. Lee, H.T. Song, S. Kim, S. Yoon, K. S. Kim, J.S. Shin, J.S. Suh and J. Cheon, “ Nanoscale size effect of magnetic nanocrystals and their utilization for cancer diagnosis via magnetic resonance imaging,” *J. Am.*

Chem. Soc., vol 127, 16, 5732-5733, 2005.
[128] C. T. Yavuz, J. T. Mayo, W. W. Yu, A. Prakash, J. C. Falkner, S. Yean, L. Cong, H. J. Shipley, A. Kan, M. Tomson, D. Natelson, V. L. Colvin, "Low-field magnetic separation of monodisperse Fe_3O_4 Nanocrystals," *Science,* vol. 314, no. 5801, 964-967, 2006.
[129] D. L. Huber, "Synthesis, properties and applications of iron nanoparticles," *Small,* vol. 1, no. 5, 482-501, 2005.
[130] V. Bliznyuk, S. Singamaneni, S. Sahoo, S. Polisetty, X. he and C. Binek , "Self assembly of magnetic Ni nanoparticles into 1D arrays with antiferromagnetic order**,"** *Nanotechnology*, vol. 20, no. 10, 1–8, 2009.
[131] S. Wu *et al.*, "Fe3O4 magnetic nanoparticles synthesis from tailings by ultrasonic chemical co-precipitation," *Mater. Lett.*, vol. 65, no. 12, pp. 1882–1884, 2011.
[132] L. Shen *et al.*, "Facile co-precipitation synthesis of shape-controlled magnetite nanoparticles," *Ceram. Int.*, vol. 40, no. 1 PART B, pp. 1519–1524, 2014.
[133] M. Abbas, B. Parvatheeswara Rao, S. M. Naga, M. Takahashi, and C. Kim, "Synthesis of high magnetization hydrophilic magnetite (Fe3O 4) nanoparticles in single reaction - Surfactantless polyol process," *Ceram. Int.*, vol. 39, no. 7, pp. 7605–7611, 2013.
[134] W. Cai and J. Wan, "Facile synthesis of superparamagnetic magnetite nanoparticles in liquid polyols," *J. Colloid Interface Sci.*, vol. 305, no. 2, pp. 366–370, 2007.
[135] Y. F. Shen, J. Tang, Z. H. Nie, Y. D. Wang, Y. Ren, and L. Zuo, "Preparation and application of magnetic Fe3O4nanoparticles for wastewater purification," *Sep. Purif. Technol.*, vol. 68, no. 3, pp. 312–319, 2009.
[136] Z. Li, Q. Sun, and M. Gao, "Preparation of water-soluble magnetite nanocrystals from hydrated ferric salts in 2-pyrrolidone: Mechanism leading to Fe3O4," *Angew. Chemie - Int. Ed.*, vol. 44, no. 1, pp. 123–126, 2004.
[137] S. Sun and H. Zeng, "Size-Controlled Synthesis of Magnetite Nanoparticles," *J. Am. Chem. Soc.*, vol. 124, no. 28, pp. 8204–8205, 2002.
[138] D. Amara, I. Felner, I. Nowik, and S. Margel, "Synthesis and characterization of Fe and Fe3O4nanoparticles by thermal decomposition of triiron dodecacarbonyl," *Colloids Surfaces A Physicochem. Eng. Asp.*, vol. 339, no. 1–3, pp. 106–110, 2009.
[139] T. Wu *et al.*, "Facile Hydrothermal Synthesis of Fe3O4/C Core-Shell Nanorings for Efficient Low-Frequency Microwave Absorption," *ACS Appl. Mater. Interfaces*, vol. 8, no. 11, pp. 7370–7380, 2016.
[140] S. Ni *et al.*, "Hydrothermal synthesis of Fe3O4nanoparticles and its application in lithium ion battery," *Mater. Lett.*, vol. 63, no. 30, pp. 2701–2703, 2009.
[141] T. J. Daou *et al.*, "Hydrothermal synthesis of monodisperse magnetite nanoparticles," *Chem. Mater.*, vol. 18, no. 18, pp. 4399–4404, 2006.
[142] C. Yang, J. Wu, and Y. Hou, "Fe3O4nanostructures: Synthesis, growth mechanism, properties and applications," *Chem. Commun.*, vol. 47, no. 18, pp. 5130–5141, 2011.
[143] C.-L. Zhu, M.-L. Zhang, Y.-J. Qiao, G. Xiao, F. Zhang, and Y.-J. Chen, "Synthesis , magnetic and electromagnetic wave absorption properties of porous Fe 3 O 4 / Fe / SiO 2 core / shell nanorods Synthesis , magnetic and electromagnetic wave absorption properties of porous Fe 3 O 4 / Fe / SiO 2 core / shell nanorods," *J. Phys. Chem. C*, vol. 114, pp. 16229–16235, 2010.
[144] J. Xu *et al.*, "Preparation and magnetic properties of magnetite nanoparticles by Sol-gel method," *J. Magn. Magn. Mater.*, vol. 309, pp. 307–311, 2007.
[145] Y. H. Deng, C. C. Wang, J. H. Hu, W. L. Yang, and S. K. Fu, "Investigation of

formation of silica-coated magnetite nanoparticles via sol-gel approach," *Colloids Surfaces A Physicochem. Eng. Asp.*, vol. 262, no. 1–3, pp. 87–93, 2005.
[146] O. M. Lemine *et al.*, "Sol-gel synthesis of 8 nm magnetite (Fe3O4) nanoparticles and their magnetic properties," *Superlattices Microstruct.*, vol. 52, no. 4, pp. 793–799, 2012.
[147] J. Eastoe, M. J. Hollamby, and L. Hudson, "Recent advances in nanoparticle synthesis with reversed micelles," *Adv. Colloid Interface Sci.*, vol. 128–130, no. 2006, pp. 5–15, 2006.
[148] A. J. Zarur and J. Y. Ying, "Reverse microemulsion synthesis of nanostructured complex oxides for catalytic combustion," pp. 65–67, 2000.
[149] M. A. Malik, M. Y. Wani, and M. A. Hashim, "Microemulsion method: A novel route to synthesize organic and inorganic nanomaterials. 1st Nano Update," *Arab. J. Chem.*, vol. 5, no. 4, pp. 397–417, 2012.
[150] M. A. López-Quintela, C. Tojo, M. C. Blanco, L. García Rio, and J. R. Leis, "Microemulsion dynamics and reactions in microemulsions," *Curr. Opin. Colloid Interface Sci.*, vol. 9, pp. 264–278, 2004.
[151] W. F. C. Sager, "Microemulsion templating," *Schr. Forschungszent. Juelich, Mater. Mater.*, vol. 10, no. Soft Matter: Complex Materials on Mesoscopic Scale, p. A6/1-A6/37, 2002.
[152] Z. L. Liu and X. Wang, "Synthesis of magnetite nanoparticles in W / O microemulsion," *J. Mater. Sci.*, vol. 39, pp. 2633–2636, 2004.
[153] H. Maleki, A. Simchi, M. Imani, and B. F. O. Costa, "Journal of Magnetism and Magnetic Materials Size-controlled synthesis of superparamagnetic iron oxide nanoparticles and their surface coating by gold for biomedical applications," *J. Magn. Magn. Mater.*, vol. 324, no. 23, pp. 3997–4005, 2012.
[154] R. Latsuzbaia, E. Negro, and G. Koper, "Bicontinuous microemulsions for high yield , wet synthesis of ultra fi ne nanoparticles : a general approach †," *Faraday Discuss.*, vol. 181, pp. 37–48, 2015.
[155] X. Sun *et al.*, "One-pot fabrication of core-shell fly ash@polypyrrole/Au composite microspheres and their performance for the reduction of nitrophenol," *Synth. Met.*, vol. 220, pp. 635–642, 2016.
[156] F. Foroughi, S. A. Hassanzadeh-tabrizi, and A. Bigham, "Nanocomposite As a Magnetic Drug Delivery System," *Mater. Sci. Eng. C*, vol. 68, pp. 774–779, 2016.
[157] J. T. Song, X. S. Zhang, M. Y. Qin, and Y. Di Zhao, "One-pot two-step synthesis of core-shell mesoporous silica-coated gold nanoparticles," *Dalt. Trans.*, vol. 44, no. 17, pp. 7752–7756, 2015.
[158] L. Yang, J. Zhu, and D. Xiao, "Synthesis and characterization of ZnSe:Fe/ZnSe core/shell nanocrystals," *J. Lumin.*, vol. 148, pp. 129–133, 2014.
[159] T. Aubert *et al.*, "Bright and stable CdSe/CdS@SiO2nanoparticles suitable for long-term cell labeling," *ACS Appl. Mater. Interfaces*, vol. 6, no. 14, pp. 11714–11723, 2014.
[160] N. D. Kandpal, N. Sah, R. Loshali, R. Joshi, and J. Prasad, "Co-precipitation method of synthesis and characterization of iron oxide nanoparticles," *J. Sci. Ind. Res. (India).*, vol. 73, no. 2, pp. 87–90, 2014.
[161] G. Bahmanrokh *et al.*, "High coercivity sized controlled cobalt-gold core-shell nano-crystals prepared by reverse microemulsion," *Mater. Res. Bull.*, vol. 48, no. 10, pp. 4039–4047, 2013.
[162] A. L. Patterson, "The scherrer formula for X-ray particle size determination," *Phys. Rev.*, vol. 56, pp. 978–982, 1939.
[163] A. Le Bail, "Whole powder pattern decomposition methods and applications: A

retrospection," *Powder Diffr.*, vol. 20, no. 04, pp. 316–326, 2005.
[164] J. R. Frisvad, N. J. Christensen, and H. W. Jensen, "Computing the scattering properties of participating media using Lorenz-Mie theory," *ACM Trans. Graph.*, vol. 26, no. 3, p. 60, 2007.
[165] C. S. Levin *et al.*, "Magnetic- Plasmonic Core-Shell Nanoparticles," *ACS Nano*, vol. 3, no. 6, pp. 1379–1388, 2009.
[166] L. Ghazanfari and M. E. Khosroshahi, "Simulation and experimental results of optical and thermal modeling of gold nanoshells," *Mater. Sci. Eng. C*, vol. 42, pp. 185–191, 2014.
[167] C. F. Bohren and D. R. Huffman, *Absorption and scattering of light by small particles*, vol. 29, no. 28. A Wiley-Interscience Publication .JOHN WILEY & SONS, 1983.
[168] P. B. Johnson and R. W. Christy, "Optical constants of the noble metals," *Phys. Rev. B*, vol. 6, no. 12, pp. 4370–4379, 1972.
[169] S. Link and M. A. El-Sayed, "Size and Temperature Dependence of the Plasmon Absorption of Colloidal Gold Nanoparticles," *J. Phys. Chem. B*, vol. 103, no. 21, pp. 4212–4217, 1999.
[170] T. H. L. Nghiem, T. N. Le, T. H. Do, T. T. D. Vu, Q. H. Do, and H. N. Tran, "Preparation and characterization of silica-gold core-shell nanoparticles," *J. Nanoparticle Res.*, vol. 15, no. 2091, pp. 1–9, 2013.
[171] L. Wang *et al.*, "Monodispersed core-shell Fe3O4@Au nanoparticles.," *J. Phys. Chem. B*, vol. 109, no. 46, pp. 21593–21601, 2005.
[172] Y. R. Cui, C. Hong, Y. L. Zhou, Y. Li, X. M. Gao, and X. X. Zhang, "Synthesis of orientedly bioconjugated core/shell Fe3O 4@Au magnetic nanoparticles for cell separation," *Talanta*, vol. 85, pp. 1246–1252, 2011.
[173] H. Chen *et al.*, "Fe3O4@Au nanoparticles as a means of signal enhancement in surface plasmon resonance spectroscopy for thrombin detection," *Sensors Actuators, B Chem.*, vol. 212, pp. 505–511, 2015.
[174] Y. Xing *et al.*, "Controllable synthesis and characterization of Fe3O4/Au composite nanoparticles," *J. Magn. Magn. Mater.*, vol. 380, pp. 150–156, 2015.
[175] I. Y. Goon, L. M. H. Lai, M. Lim, P. Munroe, J. J. Gooding, and R. Amal, "Fabrication and Dispersion of Gold-Shell-Protected Magnetite Nanoparticles: Systematic Control Using Polyethyleneimine," *Chem. Mater.*, vol. 21, no. 4, pp. 673–681, 2009.
[176] E. A. Kwizera *et al.*, "Size- and Shape-Controlled Synthesis and Properties of Magnetic-Plasmonic Core-Shell Nanoparticles," *J. Phys. Chem. C*, vol. 120, pp. 10530–10546, 2016.
[177] Z. Xu, Y. Hou, and S. Sun, "Magnetic core/shell Fe3O4/Au and Fe3O 4/Au/Ag nanoparticles with tunable plasmonic properties," *J. Am. Chem. Soc.*, vol. 129, pp. 8698–8699, 2007.
[178] S. F. Chin, K. S. Iyer, and C. L. Raston, "Facile and Green Approach To Fabricate Gold and Silver Coated Superparamagnetic Nanoparticles," *Cryst. Growth Des.*, vol. 9, no. 6, pp. 2685–2689, 2009.
[179] D. Tang, R. Yuan, and Y. Chai, "Magnetic core-shell Fe3O4@Ag nanoparticles coated carbon paste interface for studies of carcinoembryonic antigen in clinical immunoassay," *J. Phys. Chem. B*, vol. 110, pp. 11640–11646, 2006.
[180] E. Hao and G. C. Schatz, "Electromagnetic fields around silver nanoparticles and dimers," *J. Chem. Phys.*, vol. 120, no. 1, pp. 357–366, 2004.
[181] E. Limpert, W. a. Stahel, and M. Abbt, "Log-normal Distributions across the Sciences: Keys and Clues," *Bioscience*, vol. 51, no. 5, pp. 341–352, 2001.

[182] J. Zaanen, G. A. Sawatzky, and J. W. Allen, "Band gaps and electronic structure of transition-metal compounds," *Phys. Rev. Lett.*, vol. 55, no. 4, pp. 418–421, 1985.

[183] V. A. Tauc J, Grigorovici R, "Optical Properties and Electronic Structure of Amorphous Germanium," *Phys. Status Solidi*, vol. 15, pp. 627–637, 1966.

[184] W. F. J. Fontijn, P. J. Van Der Zaag, M. A. C. Devillers, V. A. M. Brabers, and R. Metselaar, "Optical and magneto-optical polar Kerr spectra of Fe3O4 and Mg 2+ or Al 3+ -substituted Fe3O4," *Phys. Rev. B*, vol. 56, no. 9, pp. 5432–5442, 1997.

[185] P. Gangopadhyay *et al.*, "Optical absorption and photoluminescence spectroscopy of the growth of silver nanoparticles," *Phys. Rev. Lett.*, vol. 94, no. 4, pp. 3–6, 2005.

[186] T. Koida *et al.*, "Correlation between the photoluminescence lifetime and defect density in bulk and epitaxial ZnO," *Appl. Phys. Lett.*, vol. 82, no. 4, pp. 532–534, 2003.

[187] S. Tongay *et al.*, "Defects activated photoluminescence in two-dimensional semiconductors: Interplay between bound, charged, and free excitons," *Sci. Rep.*, vol. 3, pp. 1–5, 2013.

[188] R. Arras, L. Calmels, and B. Warot-Fonrose, "Half-metallicity, magnetic moments, and gap states in oxygen-deficient magnetite for spintronic applications," *Appl. Phys. Lett.*, vol. 100, p. 032403, 2012.

[189] D. Z. Chengye Yu, Zhengwen Yang*, Jianbei Qiu, Zhiguo Song, "Enhanced photoluminescence property and mechanism of Eu3+-doped tellurite glasses by the silver and gold nanoparticles," *J. Am. Ceram. Soc.*, vol. 101, no. 2, pp. 612–623, 2018.

[190] L. Wang and H. S. Zhou, "Green synthesis of luminescent nitrogen-doped carbon dots from milk and its imaging application," *Anal. Chem.*, vol. 86, no. 18, pp. 8902–8905, 2014.

[191] S. K. Bhunia, N. Pradhan, and N. R. Jana, "Vitamin B1 derived blue and green fluorescent carbon nanoparticles for cell-imaging application," *ACS Appl. Mater. Interfaces*, vol. 6, no. 10, pp. 7672–7679, 2014.

[192] P. A. Dresco, V. S. Zaitsev, R. J. Gambino, and B. Chu, "Preparation and peoperties of magnetite and polymer magnetite nanoparticle," *Langmuir*, vol. 15, no. 12, pp. 1945–1951, 1999.

[193] L. E. Jennings and N. J. Long, "'Two is better than one'—probes for dual-modality molecular imaging," *Chem. Commun.*, no. 24, p. 3511, 2009.

[194] B. Kalska-Szostko, U. Wykowska, and D. Satuła, "Magnetic nanoparticles of core-shell structure," *Colloids Surfaces A Physicochem. Eng. Asp.*, vol. 481, pp. 527–536, 2015.

[195] M. E. F. et al. Brollo, "Compact Ag@Fe3O4 Core-shell Nanoparticles by Means of Single-step Thermal Decomposition Reaction.," *Sci. Rep.*, vol. 4, p. 6839, 2014.

[196] D. A. Balaev, S. V. Semenov, A. A. Dubrovskiy, S. S. Yakushkin, V. L. Kirillov, and O. N. Martyanov, "Superparamagnetic blocking of an ensemble of magnetite nanoparticles upon interparticle interactions," *J. Magn. Magn. Mater.*, vol. 440, no. November 2016, pp. 199–202, 2017.

[197] C. Caizer, "T 2 law for magnetite-based ferrofluids," *J. Phys. Condens. Matter*, vol. 15, pp. 765–776, 2003.

[198] H. Zeng, S. Sun, J. Li, Z. L. Wang, and J. P. Liu, "Tailoring magnetic properties of core/shell nanoparticles," *Appl. Phys. Lett.*, vol. 85, no. 5, pp. 792–794, 2004.

[199] A. Ahadpour Shal and A. Jafari, "Study of Structural and Magnetic Properties of Superparamagnetic Fe3O4–ZnO Core–Shell Nanoparticles," *J. Supercond. Nov. Magn.*, vol. 27, no. 6, pp. 1531–1538, 2014.

[200] E. Iglesias-Silva, J. Rivas, L. M. León Isidro, and M. A. López-Quintela, "Synthesis of silver-coated magnetite nanoparticles," *J. Non. Cryst. Solids*, vol. 353, no. 8–10, pp. 829–831, 2007.
[201] E. Lima, A. L. Brandl, A. D. Arelaro, and G. F. Goya, "Spin disorder and magnetic anisotropy in Fe3 O4 nanoparticles," *J. Appl. Phys.*, vol. 99, no. 083908, pp. 1–10, 2006.
[202] M. J. Benitez *et al.*, "Structural and magnetic characterization of self-assembled iron oxide nanoparticle," *J. Phys. Condens. Matter*, vol. 23, no. 126003, pp. 1–12, 2011.
[203] S. F. Edwards and P. W. Anderson, "Theory of spin glasses," *J. Phys. F Met. Phys.*, vol. 5, pp. 965–974, 1975.
[204] D. De, A. Karmakar, M. K. Bhunia, A. Bhaumik, S. Majumdar, and S. Giri, "Memory effects in superparamagnetic and nanocrystalline Fe 50Ni 50 alloy," *J. Appl. Phys.*, vol. 111, no. 033919, pp. 1–3, 2012.
[205] K. Binder and A. P. Young, "Spin glasses: Experimental facts, theoretical concepts, and open questions," *Rev. Mod. Phys.*, vol. 58, no. 4, pp. 801–976, 1986.
[206] M. J. Benitez *et al.*, "Evidence for Core-Shell Magnetic Behavior in Antiferromagnetic Co3O4 Nanowires," *Phys. Rev. Lett.*, vol. 101, no. 097206, pp. 1–4, 2008.
[207] M. J. Benitez, O. Petracic, H. Tuysuz, F. Schuth, and H. Zabel, "Fingerprinting the magnetic behavior of antiferromagnetic nanostructures using remanent magnetization curves," *Phys. Rev. B*, vol. 83, no. 134424, pp. 1–9, 2011.
[208] S. Huang, S. Y. Wang, A. Gupta, D. A. Borca-Tasciuc, and S. J. Salon, "On the measurement technique for specific absorption rate of nanoparticles in an alternating electromagnetic field," *Meas. Sci. Technol.*, vol. 23, no. 035701, pp. 1–6, 2012.

List of Publications

Publications:

The following papers have been published during PhD work.

1. Size Selectivity of magnetite core- (Ag/Au) shell nanoparticles for multimodal imaging applications: **Pinki Singh**, Chandan Upadhyay; **Mater. Res. Express** 4, 105401 (2017).
2. Fine Tuning of Size and Morphology of Magnetite Nanoparticles Synthesized by Microemulsion: **Pinki Singh**, Chandan Upadhyay; **AIP Conf. Proc**. 1953 A, 030051 (2018).
3. Role of Silver Nanoshells on Structural and Magnetic Behavior of Fe_3O_4 nanoparticles: **Pinki Singh**, Chandan Upadhyay; **J. Magn. Magn. Mater**. 458, 39 (2018).
4. Novel facets of multifunctional Ag@Fe_3O_4 core-shell nanoparticles for multimodal imaging applications: **Pinki Singh**, Bipin Kumar Gupta, Nand Kishore Prasad, Pramod Yadav and Chandan Upadhyay; **J. App. Phys**. 124 (7), 074901 (2018).
5. Signatures of Consolidated superparamagnetic and spin-glass behavior in magnetite- silver core-shell nanoparticles: **Pinki Singh**, Manjari Shukla and Chandan Upadhyay; **Nanoscale** 10, 22583 (2018).
6. Janus shaped plasmonic-magnetic silver-magnetite nanostructures for multimodal applications. **Pinki Singh**, Purnima Bharti, Asnit Gangwar, Nand Kishore Prasad and Chandan Upadhyay; **Jpn J Appl Phys** 58, 105001 (2019).

Conference Presentations:

1. Silver and Gold coated magnetite superparamagnetic nanoparticles for application as multimodal imaging agent; **Pinki Singh** and Chandan Upadhyay; **International Conference** on "Advances in Biological System and Materials Science in Nanoworld", Indian Institute of Technology (Banaras Hindu University), 19 -23 February, 2017.

2. Size Selectivity of magnetite core- (Ag/Au) shell nanoparticles for multimodal imaging applications**, Pinki Singh** and Chandan Upadhyay; **Institute Day**, Indian Institute of Technology (Banaras Hindu University), February 24- 26, 2017.

3. Fine Tuning of Size and Morphology of Magnetite Nanoparticles Synthesized by Microemulsion**; Pinki Singh** and Chandan Upadhyay; **2nd International Conference on Condensed Matter & Applied Physics (ICC 2017)** Govt. Engineering College, Bikaner, Rajasthan, November 24-25, 2017.

4. **Investigation of Lumino-magnetic Fe_3O_4 and Ag@Fe_3O_4 nanoparticles; Pinki Singh**, Abhishek Tripathi and Chandan Upadhyay; **Institute Day,** Indian Institute of Technology (Banaras Hindu University), February 16- 18, 2018.

5. Development of Lumino-Magnetic Iron Oxide Nanoparticles for Multimodal Applications, **Pinki Singh** and Chandan Upadhyay; **12th International Conference on the Scientific and Clinical Applications of Magnetic Carriers,** University of Copenhagen, Denmark, May 22-26, 2018.

APPENDIX I

MATLAB Programs used for calculation of Mie Coefficients and Efficiency for Core-Sell Nanostructures:

Mie Coefficients

```
function result = Miecoefficients_xy(n1,n2,a,b)

%calculation of Mie coefficients xq,yq of orders q=1 to qmax; value of size %parameters a=k*x and b=k*y where k=(2*π)/λ=wavenumber of the surrounding %medium; n1=refractive index of inner medium (magnetite) with radius 'x', %n2=refractive index of outer medium (gold/silver) of radius 'y'


n1=1.938; n2= 0.1734+i*5.7092; a=0.003488889; b=0.017444444;
v1=n1.*a;                    %v1,v2,v4 =%Bessel function arguments
v2=n2.*a;
v3=n1.*b
v4=n2.*b;
m=n2./n1;
qmax=round(2+b+4*b.^(1/3));              %infinite series truncated after qmax   terms   proposed by Bohren
                                         and Huffman (1983)
MAXIMUM=max(abs(v3),abs(v4));
qstart=round(max(qmax,MAXIMUM)+16);   %finds initial value of q for Dq(v)
q=(1:qmax);
der(qstart)=0+0i; v=v1;             %Dq(v)is log derivative of
                                    %psi_q(Bessel fn),
for p=qstart:-1:2                                   %loop for the calculation of Dq(v)
                                                     %using reccurence formula; p varies
                                                     %from qstart to 2 with increment -1
```

```
der(p-1)=p./v-1/(der(p)+p./v);          %derivative of p-1=der(nstart-1), der
                                                    %(nstart-2)........der(1),der(2).
end;
derv1=der(q);                        %a column matrix Dq(n1a) is obtained
                                                   %with elements der(1),der(2) upto
                                                   %der(qmax).
v=v2;                               %loop for calculation of column matrix
                                                   %Dq(n2a),v2=n2a


for p=qstart:-1:2
    der(p-1)=p./v-1/(der(p)+p./v);
end;
derv2=der(q);
v=v4;                               %loop for calculation of column matrix
                                                   %for Dq(n2b),v4=n2b
 for p=qstart:-1:2
  der(p-1)=p./v-1/(der(p)+p./v);
end;
derv4=der(q);
%The values of logarithmic derivatives of psi and chi (Bessel functions) %Dq(v) have been calculated above.
%calculation of psi,gsi and chi functions and their derivatives
qt = (q+0.5);
sqrootv2=sqrt(0.5*pi*v2);
sqrootv4=sqrt(0.5*pi*v4);
sqrootb=sqrt(0.5*pi*b)
bessel1v2=sqrootv2.*besselp(qt,v2);    %computation for first kind Bessel
                                                   %function Jq(n2a)
```

```
bessel1v4=sqrootv4.*besselp(qt,v4);    %calculation for first kind Bessel
                                                    %function Jq(n2b)
bessel1b= sqrootb.*besselp(qt,b);      %calculation for first kind Bessel
                                                    %function Jq(b)
bessel2v2=-sqrootv2.*besselb(qt,v2);   %second kind bessel function Yq(n2a)
bessel2v4=-sqrootv4.*besselb(qt,v4);   %second kind bessel function Yq(n2b)
bessel2b=-sqrootb.*besselb(qt,b);      %second kind bessel function Yq(b)
sphbessel1b=[sin(b), bessel1b(1:qmax-1)]; %spherical bessel function Jq-1(v),
                                                    %J0(v)=sinv/v
sphbessel2b=[cos(b), bessel2b(1:qmax-1)];  %Spherical Bessel fn Yq-1(v),
                                                    %Yo(v)=-cosv/v
hankelbq=bessel1b-i*bessel2b;          %hankel function hn(z)=Jq(v)+i*Yq(v)
hankelbq_1=sphbessel1b-i*sphbessel2b;  %hq-1(v) =Jq-1(v)+i*Yq-1(v)

%calculation of Aq and Bq
Dv1=m.*derv1-derv2;
cv2=derv1./m-derv2;
ev2=bessel1v2./bessel2v2;
ev4=bessel1v4./bessel2v4;
fv1=Dv1.*ev2./bessel1v4;
gv1=Dv1.*(bessel1v4-bessel2v4.*ev2)+(bessel1v4./bessel1v2)./bessel2v2;
lv2=cv2.*ev2./bessel1v4;
tv2=cv2.*(bessel1v4-bessel2v4.*ev2)+(bessel1v4./bessel1v2)./bessel2v2;
P1=fv1./gv1;
Q1=lv2./tv2;
%calculation of Dq tilde and Gq tilde
P=P1+derv4;
Q=Q1+derv4;
```

```
s=P./n2+q./b;

t=n2.*Q+q./b;

%calculation for xq and yq

xq=(bessel1b.*s-sphbessel1b)./(hankelbq.*s-hankelbq_1);


yq=(bessel1b.*t-sphbessel1b)./(hankelbq.*t-hankelbq_1);

%matrix of coefficients xq and yq

result=[xq; yq];
```

Mie Efficiency

```
function result = Mie_efficiency(n1,n2,a,b)


n1=1.938;n2=0.1734+(5.7092)*i;a=0.003488889;b=0.017444444;


qmax=round(2+b+4*b.^(1/3));      %infinite sum truncated after qmax terms

q=(1:qmax);qtimes=2*q+1;

bsq=b.*b;


fn=Miecoefficients_xy(n1,n2,a,b);


xqreal=(real(fn(1,:)));         %real component of xq,fn(1,:) gives 1st row

                                       %and all columns,in fn=[xq;yq] row1=xq and

                                       %row2=yq

xqim=(imag(fn(1,:)));           %imaginary component of xq

yqreal=(real(fn(2,:)));         %real part of yq

yqim=(imag(fn(2,:)));           %imaginary part of yq
```

```
%Scattering Efficency is obtained by integrating total scattered directions %in all directions and the Extinction Efficiency is calculated from the %Extinction theorem (Ishimaru and Van De Halst),also known as forward-
%scattering theorem.
%calculation for extinction Efficiency Qex
dq=qtimes.*(xqreal+yqreal);
SUM=sum(dq);
qex=2*SUM./bsq;

%calculation for Scattering Efficiency Qsc
nq=qtimes.*(xqreal.*xqreal+xqim.*xqim+yqreal.*yqreal+yqim.*yqim);
tn=sum(nq);
qsc=2*tn./bsq;

%calculation for Absorption Efficiency Qab
qab=qex-qsc;
result=[qex qsc qab];
```