Madhuri Mandal (Goswami)

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Dr. Madhuri Mandal (Goswami) did her Ph.D from IIT Kharagpur and 6 years post doctoral research in the University of Alabama, USA, at SINP, Kolkata and then in SNBNCBS, Kolkata. Then Visiting Faculty Fellow in SNBNCBS, Kolkata. Research mainly focuses on the synthesis, characterization and applications of magnetic nanoparticles including hyperthermia therapy, drug release, biosensor etc.

Supervision of Research / Students

Ph.D. Students

1. Chaitali Dey, Title: Synthesis of transition metal based magnetic nanoparticles for drug delivery and catalytic activity, Ongoing
2. Debarati De, Title: Design of biocompatible fluorescent magnetic nanoparticles for imaging of cancer cells and possible theranostic use, Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Arpita Das, Calcutta University, DNA Engineered Cobalt Ferrite Nanoparticles: Magnetic And Optical Studies For Hyperthermia Application, Completed.
2. Madhumanti Neogi, Calcutta University, Title: Synthesis of magnetic nanoparticles and their characterization for biological application, Completed.

Teaching activities at the Centre

1. Fall, PHY-391, I.Ph.D students, UV-visible spectroscopy practical, seven students

Publications in Journals

1. Chaitali Dey, Arka Chaudhuri, Ajay Ghosh, **Madhuri Mandal Goswami;** *Magnetic cube-shaped $NiFe_2O_4$ nanoparticles: An effective model catalyst for nitro compound reduction;* ChemCatChem; 2017; **9;** 1953.
2. Debarati De and **Madhuri Mandal Goswami;** *Shape induced acid responsive heat triggered highly facilitated drug release by cube shaped magnetite nanoparticles;* Biomicrofluidics; 2016; **10;** 064112.
3. Chaitali Dey, Kaushik Baishya, Arup Ghosh, **Madhuri Mandal Goswami,** Ajay Ghosh, Kalyan Mandal; *Improvement of drug delivery by hyperthermia treatment using magnetic cubic cobalt ferrite nanoparticles;* J. Mag. Mag. Mater.; 2017; **427;** 168-174.
4. **Madhuri Mandal Goswami;** *Synthesis of Micelles Guided Magnetite (Fe_3O_4) Hollow Spheres and Their Application for AC Magnetic Field Responsive Drug Release;* Scientific Reports; 2016; **6;** 35721.

Lectures Delivered

1. Synthesis of Magnetite (Fe_3O_4) Hollow Spheres and their Size Dependent Stimulated Cancer Drug Release Study, Haldia Institute of Technology, Haldia, March, 2017.

Sponsored Projects

1. **Title:** Preparation of magnetic nanoparticles and proper biofunctionalization for their use in drug delivery and release, **Sponsor:** DST, New Delhi, **Period of funding:** For 3 years, from June 2014- June-2017.
2. **Title:** Synthesis and Engineering of Magnetic Nanoparticles for their in-vitro Application in Hyperthermia Therapy, **Sponsor:** S. N. Bose National Centre for Basic Sciences, Salt Lake Kolkata, **Period of funding:** For 3 years, from March 2016- March-2019.

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. Prof. Ajay Ghosh, University of Calcutta (Sl. No.1 and 3)

Significant research output / development during last one year

General research areas and problems worked on

- Synthesis, characterization and application of various types of magnetic nanoparticles with change of size, shape and physical properties.
- Drug loading and AC magnetic field, pH, temperature etc. stimuli driven drug release studies
- Theranostics by cancer cell imaging and cell death study using hyperthermia therapy

- Biosensor development

Interesting results obtained

Many types of magnetic hollow like particles can be synthesized by our method by co-precipitating the precursor salts using solvothermal technique. Using precursor salts, Urea, Ethylene Glycol (EG) mixture and micelles under prolonged heat treatment for 15 hrs produce hollow like particles. Micelles here play an important role in synthesis of hollow like particles. The mechanism is shown below.

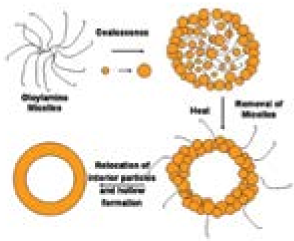
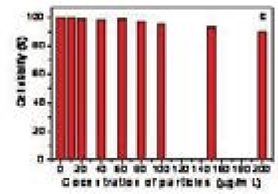


Fig: Mechanism of formation of hollow particle

Initially smaller particles and micelles coalesce to each other and bigger particles are formed which is known as Oswald ripening. Then during prolonged heat treatment the micelles from interior portion of the bigger particles are come out and an out ward force make the particles hollow like particles as shown above.

Not only hollow shaped, other shaped particles are also prepared by using different micelles in different manners such as cube, sphere atc. are also formed. Magnetic properties are studied for the functionalized and nonfunctionalized particles. Difference in magnetic properties is observed for functionalized particles from the nonfunctionalized one. The AC magnetic field dependent studies are made for all types of particles. Here we see cube shaped particles differ from the hollow like particles. In case of magnetic measurements we see that co-ferrite particles are more hard in magnetic nature so their hysteresis loss is higher. So they produce higher loss power compare to the same shaped magnetite one. Hence this way by changing from material to material we can change the magnetic properties and can produce the particles of our desired quality.

Then those particles are functionalized with different bio-molecules like DNA, folic acid, to make them biocompatible and to attach them selectively to cancer cells. Then these particles are treated with normal as well as cancer cells and effects of these particles are seen. Cytotoxicity studies are made on these functionalized particles. Particles are seen to be non toxic in nature. The cytotoxicity study made is presented in following histogram. More than 90 % of cells remain alive after treatment of upto 200 micro gm/mL of particle dispersion which is depicted by the following histogram.



Drug loading and release studies are done by these particles under different stimuli like, AC magnetic field, heat, pH etc. Then these particles are loaded with cancer drugs DOX, and drug release study is done at different temperatures and pH. We have measured drug loading efficiency for both the cube and hollow particles and have seen that loading efficiency for hollow like particles is higher. In case of drug release at lower pH and higher temperature better release takes place. At lower pH the drug molecules detached from the particles with more ease due to slight dissolution of the particles at lower pH and at higher temperature due to thermal agitation bonding between particles and drugs are broken and drug release is favored. Among cube shaped and hollow like particles the release rate for hollow shaped particles are better at same condition. It is because the hollow like particles can load more amount of the drug. Hence release rate also become better for these particles.

Proposed research activities for the coming year

Currently cancer is one of the harmful diseases in the world and taking the shape of epidemic disease. In present cancer therapies several side effects can occur and many normal cells of body are affected. In case of chemotherapy cancer drug some time become so toxic it causes death to the cancer patient. Detection of cancer in early stage and therapy of cancer by selected drug delivery systems without hampering the whole body may reduce the adverse side effects originated due to present therapies. The magnetic nanoparticles having suitable magnetic properties with the attachment of bio-friendly fluorescent reagents may provide a new direction for such therapeutic purpose. We have seen in our previous studies that the magnetic nanoparticles after tagging with some non-fluorescent molecules show highly fluorescent properties and after tagging with some organic molecules (some specific DNA molecules and some natural products) selectively attach with cancer cells. On the other hand it has been observed that magnetic nanoparticles under an alternating magnetic field produce heat and helps to kill cancer cell if heating can be controlled. Magnetic nanoparticles with tuneable magnetic properties, biocompatibility, stability etc. are very useful in such application, where hyperthermia technique is considered. From these properties we are motivated to utilize these functionalised particles for such theranostic use. Our concern is to synthesize the fluorescent magnetic nanoparticles and to tag them selectively to the cancer cell for proper theranostic use and hence do the characterization of the particles in this direction.