Novel Route to Incorporating Magnetic Nanoparticles in Thermoresponsive Microgel

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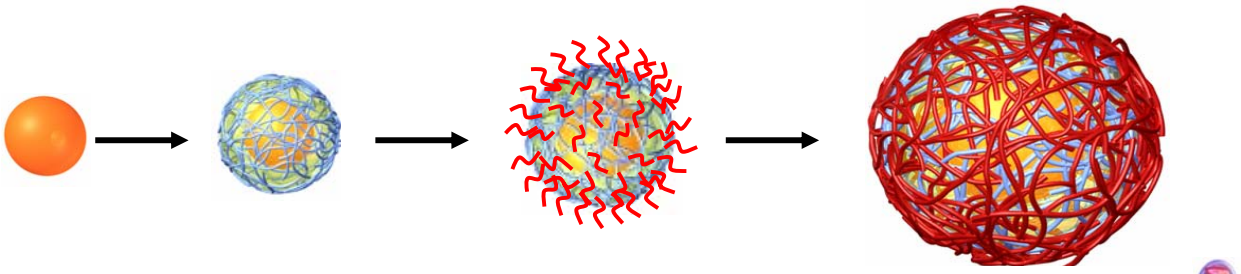
Present scientific literature demonstrates a growing interest in nanobiotechnology, driven primarily by their application in new sensing, diagnostic, and therapeutic capabilities. There is currently immense interest in the synthesis of microcapsules with unique and tailored properties.

We have developed a novel route for the synthesis of thermoresponsive magnetic nanoparticles. In the first step maghemite (γ-Fe_2O_3) was synthesized using a conventional precipitation technique. The magnetic nanoparticles (MNPs) were then functionalized with poly(acrylic acid) (PAA) resulting in particles with a diameter of around 90 nm. The PAA coated maghemite was then coated with the monomer N-isopropylacrylamide (NiPAM). Dynamic light scattering revealed a size increase of 15nm. For the conversion of the NiPAM monomer-coating into poly-NIPAM, surfactant-free emulsion polymerisation (SFEP) was initiated at 75°C in a "batch process" using potassium peroxodisulfate (KPS) as initiator and N,N-methylenbis(acrylamide) (BIS) as crosslinker.

X-Ray Diffraction studies show the presence of maghemite (γ-Fe_2O_3). MNPs encapsulated with poly-NIPAM display thermoresponsive behavior with a hydrodynamic radius going from 170nm (20°C) in the swollen state to 100nm (40°C) in the collapsed state, with a Lower Critical Solution Temperature (LCST) around 32 ^{o}C. The particles are characterized by electrophoretic measurements (zeta potentials and mobility), Superconducting Quantum Interference Device measurements (SQUID), electron microscopy and thermogravitometry analysis (TGA).

The unique combination of thermoresponsivity and magnetism opens up novel perspectives with regards to the development of remotely controlled drug carriers. This is underlined by cell incubation tests using tumor cells which show distinct particle incorporation.



Schematic representation of the encapsulation of MNPs in thermoresponsive microgel.