Field-directed Assembly of Magnetic Nanoparticles and Potential Application in Biomedical Nanotechnology

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Self-assembly of nanoparticles into complex structures has been attracting interests both from fundamental research and industrial application. By non-covalent interactions, the nanoparticles can form ordered structures in equilibrium state or far from equilibrium state. Of more importance, the collective property can be regulated by the assembled morphology and the interaction between building blocks. Therefore, the assembled nanoparticles can exhibit some novel behaviors besides the unique property of individual units.

Magnetic nanoparticles have shown promising potentials for biomedical applications, such as MRI contrast agent, drug delivery system, hyperthermal therapy and tissue repair. Especially when the assembly of magnetic nanoparticles was directed by external magnetic field, the magnetic moments of nanoparticles will be aligned with identical orientation and the dipolar interaction between nanoparticles was greatly enhanced. Thus, the physics of assembly process will greatly influence the collective behavior of magnetic nanoparticles in application.

In our group, magnetic fields including magnetostatic field and alternating magnetic field have been utilized to direct the assembly of magnetic nanoparticles. It was discovered that the assembly directed by alternating magnetic field was in mechanism different from that directed by magnetostatic field. Additionally, the collective magnetic property was altered from the superparamagnetism into the ferromagnetism by the field-directed assembly. Due to this transition, the remanence and the anisotropy emerged in the assemblies. The remanence can generate a local micro-magnetic field to affect the growth and differentiation of cells while the anisotropy can enhance the collective magnetothermal effect of magnetic nanoparticles with higher controllability and biological safety. These points will favor the application of magnetic nanoparticles in the practical biomedical issues and the mechanism will be discussed in my talk.