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Hyperthermic Property of SiO_2 Coated γ-Fe_2O_3 Nanocomposite Powder

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Hyperthermia is a type of treatment in which body tissue is exposed to high temperatures of 41~45℃ to damage and kill cancer cells or to make cancer cells more sensitive to the effects of radiation and certain anticancer drugs. It is considered as "main-stream" as surgery, chemotherapy and radiation, and is now recognized as the "fourth modality" in approved cancer treatment. Especially, local hyperthermia under applied AC field using superparamagnetic iron oxide nanoparticle is more desirable in practical thermotherapy of cancer cell without any pains and harmful aftereffects to the patients. In this study, the hyperthermic magnetic heating effect of nanosized γ-Fe_2O_3 particle coated by body-compatible SiO_2 which is synthesized by chemical vapor condensation (CVC) process.

Two metalorganic precursors of iron(III) acetylacetonate and tetraethylorthosilicate (TEOS) were used to co-synthesize SiO_2 coated γ-Fe_2O_3 nanocomposite particle. The vaporized precursors were fed into the hot wall reactor in which maintained at 900℃ and 50 mbar, with the carrier gas (He) of 2 *l*/min. and the reaction gas (O_2) of 3 *l*/min. The precursors were decomposed and reacted with O_2 to form SiO_2 coated γ-Fe_2O_3 nanocomposite particle in reactor and condensed on the water cooled collect chamber. The synthesized nanocomposite particle were characterized by using XRD, TEM, EDS and VSM. Also the effect of magnetic heating was measured under the magnetic field of 6 mT and elevated frequency of 40~140 kHz which is optimized applied AC field to human body, and compared to uncoated γ-Fe_2O_3 nanoparticle by same synthetic process.

The nanocomposite particle was consisted of 10~30 nm sized γ-Fe_2O_3 particle coated by 5 nm thickness of amorphous SiO_2 forming the slight agglomeration. From TEM-EDS analysis, the composition of the nanocomposite particle was 90wt% of SiO_2 and 10wt% of γ-Fe_2O_3. The satuated magnetization (Ms) and retentivity (Mr) of nanocomposite particle were very low values of 3.62 emu/g and 0.118 emu/g, respectively, and it represented the superparamagnetic behavior over the blocking temperature of 70 K. This is mainly due to well dispersion of small sized γ-Fe_2O_3 nanoparticle in the SiO_2 matrix.

The generated heat from magnetic nanoparticles increased with increase of applied frequency and the amount of γ-Fe_2O_3 nanoparticle. From the generated heats of SiO_2 coated γ-Fe_2O_3 nanocomposite particle and reference γ-Fe_2O_3 nanoparticle, the specific power losses (SAR) which means the magnetic heating effect of magnetic nanoparticle in alternative AC field were theoretically calculated based on superparamagnetic relaxation loss. In the results, the SAR value of SiO_2 coated γ-Fe_2O_3 nanocomposite particle was two times higher than the reference γ-Fe_2O_3 nanoparticle. This implies that the SiO_2 coated γ-Fe_2O_3 nanocompsoite particle has excellent superparamagnetic behavior because the well dispersed γ-Fe_2O_3 nanoparticle does not interact each other in the SiO_2 matrix.

Conclusively, the SiO_2 coated γ-Fe_2O_3 nanocompsoite particle are successfully synthesized by CVC process and shows much higher superparamagnetism. And it represents higher magnetic heating effect uncer applied magneic field. So it is expected that this SiO_2 coated γ-Fe_2O_3 nanocompsoite particle has higher potential as the media materials for hyperthermia treatment.