別紙様式８

研　究　主　論　文　抄　録

論文題目　　Synthesis of carbon-coated metal, carbide nanoparticles and sulfide nanocrystals by pulsed plasma in liquid
（液中パルスプラズマ法による炭素被覆金属、炭化物ナノ粒子及び硫化物ナノ結晶の合成）

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主論文要旨
《本文》

Synthesis of carbon-coated metal, carbide nanomaterials and sulfide nanocrystals is challenging area in materials science and engineering. Magnetism, biocompatibility and high temperature stability of carbon-coated metal, carbide, and sulfide nanomaterials enable to use them in different applications.

This work presents synthesis of onion-like carbon-coated metal (Co-C, Ni-C, and Fe-C), carbide (WC_{1-x}@C and TiC@C), and sulfide (CuS) nanomaterials by using pulsed plasma in liquid method (PPL). Pulsed plasma in liquid is simple and inexpensive technique for nanomaterials synthesis. Syntheses of onion-like carbon-coated metal (Co-C, Ni-C, and Fe-C), carbide (WC_{1-x}@C and TiC@C), and sulfide (CuS) nanomaterials were carried out by using low electrical energy, no vacuum and pressure, without any additives. Properties of these nanomaterials were studied by means of X-ray diffraction (XRD), transmission electron microscopy (TEM), high resolution transmission electron microscopy (HRTEM), field emission scanning electron microscopy (FE-SEM), Raman spectroscopy, atomic emission spectroscopy, vibrating sample magnetometer (VSM), Fourier transform infrared spectroscopy (FT-IR), thermal gravimetric analysis (TGA), X-ray photoelectron spectroscopy (XPS) and cytotoxicity studies, etc.

For detecting the biocompatibility of as-synthesized onion-like carbon-coated metal (Co-C, Ni-C, and Fe-C), and sulfide (CuS) nanomaterials, we have performed *in vitro* cytotoxicity analyses, using the A549 cell line (Human lung adenocarcinoma epithelial cells), and MCF-7 (breast cancer) cells. Carbon-coated magnetic nanoparticles of Co, Ni, and Fe synthesized by PPL method showed low cytotoxic effects on the

cancer cells. As a part of investigation, different cancer cell lines and two types of assays (MTT and XTT) were used for cytotoxicity measurements. Results obtained in this study are making possible to apply onion-like carbon-encapsulated Co, Ni, and Fe magnetic nanoparticles *in vivo* cancer treatment applications.

Carbides of WC_{1-x} and TiC are promising to be applicable in high temperature applications. HRTEM studies revealed the graphitic carbon coatings on the surface of the WC_{1-x} and TiC carbide nanoparticles. Thermal gravimetric analyses showed high thermal stability of WC_{1-x} and TiC synthesized by pulsed plasma in liquid method. We have analyzed these carbide nanoparticles, and found their thermal stability, which is higher comparing to samples synthesized by other methods.

Copper sulfide (CuS) nanoparticles have attracting a great interest nowadays in medicine, because of cancer cell eliminating property, and also in photodegradation of organic wastes because of photocatalytic property. CuS nanoparticles prepared by pulsed plasma in liquid method showed lower toxicity and good photocatalytic properties, comparing to commercial CuS sample. These features of CuS synthesized by pulsed plasma in liquid are highlighting its medical and photocatalytic applications.

In this dissertation, structure, morphology and surface characterization for carbon-coated metal, carbide nanoparticles and sulfide nanocrystals synthesized by pulsed plasma in liquid were discussed.