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Alternating current electrophoretic deposition and infiltration of nanomaterials in aqueous suspension

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Electrophoretic deposition (EPD) is attracting many researchers nowadays because of its many advantages, such as simple deposition apparatus, fast growth rate and the ease of deposition with a controlled thickness. Recently, eco-friendly alternating current electrophoretic deposition (AC-EPD) using an aqueous suspension is emerging as a successful processing technique for the deposition of a range of particles, which was proven to minimize the evolution of gas bubbles. In the present work, the asymmetric AC-EPD of various nanoparticles, such as Si, C, β-SiC, TiO_2, Al_2O_3, $BaTiO_3$ and ZrB_2 by aqueous colloidal processing were examined. The rheological behavior of nanoparticles as a function of pH was studied using zeta potential, viscosity and conductivity measurements. By adding a suitable aqueous dispersant and binder at optimum pH, a well-dispersed suspension containing nanoparticles was prepared in deionized water. A square-shaped asymmetric waveform with an asymmetry factor of 4 was considered for AC-EPD. Homogeneous thin and thick films over a large area were deposited successfully by AC-EPD. The microstructure of the deposited green films was observed by transmission and scanning electron microscopy. AC-EPD revealed uniform and crack-free films when compared to the non-uniform film morphology prepared under a direct current (DC). The effects of the AC voltage, frequency and time on the deposit yield were also investigated. In a following step, AC-EPD combined with the application of ultrasonic pulses was used effectively to infiltrate the SiC and ZrB_2 nanoparticles with suitable sintering additives into the fine voids of SiC/C fabrics to fabricate tube and square-shaped fiber-reinforced composites for high temperature applications.

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Functionalized gold nanoparticles based colorimetric sensors for heavy metal ions from waste water

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Contamination of water by heavy or toxic metal ions can lead to serious environmental and human health problems. There are several toxic metal ions (e.g., mercury, cadmium and lead) can cause serious environmental and human health problems because of their acute and chronic toxicity to biological system. For example, the most common form of mercury in water is mercuric ion (Hg^{2+}) which is widely released to the environment from industrial source, shows high toxicity mainly on renal and nervous systems through the disruption of enzyme activity. On the other hand, Lead ions (Pb^{2+}) released to the environment through dyes, gasoline and batteries and it can cause neurological, cardiovascular and developmental disorders in especially children. Another highly toxic metal ion: Cadmium (Cd^{2+}) found in many end user products such as plastics, batteries, cigarettes and dyes. Therefore, monitoring of toxic metal ions in water (drinking, sea, lake, etc.) is very essential in terms of improving human health and water quality. There are several methods used for heavy or toxic metal ion detection which often based on chromatographic and spectroscopic techniques such as inductively coupled plasma mass spectrometry (ICP-MS), atomic absorption spectrometry (AAS), high performance liquid chromatography (HPLC) and electrochemistry. These methods are highly sensitive and selective and require high sophisticated instruments, expensive, time-consuming and non-portable. Therefore, low cost, simple, rapid, portable and green methods for metal ion detection are still highly desired. In this regard, colorimetric methods based on functionalized gold nanoparticles (AuNPs) are convenient and attractive and can satisfactorily meet these demands. Because AuNPs exhibit high extinction coefficients, strongly distance-dependent optical properties and colors arising from AuNPs at nanomolar concentrations allow them to be easily monitored by the naked eye without the aid of any advanced instruments.

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