BrainKorea FOUR 21

Mechanical Eng. SEMINAR

Sensing and Monitoring using Nanocomposites & Beyond

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D A T E Tuesday, May 16, 2023(16:30.-)

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Highly accurate, miniaturized components that consist of a variety of materials will play key roles in the future development of a broad spectrum of products, such as wearable devices, lab-on-chips, subminiature actuators and sensors. With the advent of the Internet of Things (IoTs) and Industrie 4.0, the development of miniature and reliable devices will be far-reaching in the enhancement of quality of life and economic growth.

Smart polymeric nanocomposites are promising new materials applicable as media for nano-patterned surfaces. Much attention is being paid to carbon-based nanoparticles as fillers in polymer matrices, due to their outstanding mechanical, electrical and thermal properties. In particular, carbon nanotubes (CNTs) and graphenes are effective in the fabrication of electrically and thermally conductive polymer composites compared to metallic particles or carbon black, mainly due to their high aspect ratios (i.e. ~100-1000).

The sensors consisted of polymer reinforced with multi-walled carbon nanotubes (MWCNTs)/graphenes using a variety of manufacturing techniques. The sensors were electrically poled to generate piezoelectric phases. Both the piezoresistive and piezoelectric characteristics of the nanocomposite were utilized for improved performance of the sensors.

Another important aspect is cost effective manufacturing of conductive electrode patterns onto flexible substrates is vital for multifunctional and flexible systems. Conventional chemical etching, vacuum deposition and electrodeless plating are expensive and potentially hazardous to flexible substrates. Others have used metallic nanoparticle inks, such as silver nanoparticles, through inkjet printing, but the high cost of silver nanoparticles prevents mass production. We have recently developed a simple method to prepare hybrid copper-silver conductive tracks through flash light sintering. We demonstrate some of examples of the sensors, hybrid copper electrodes and energy storage applications including Lithium-Ion batteries.