2008 TAIWAN INTERNATIONAL SCIENCE FAIR

CATEGORY : Engineering

PROJECT : Promoting Metal Adhesion to Electrospun Fibers and Polymer Thin Films with Gold Nanoparticles and Supercritical CO_2

AWARDS : Engineering First Award

SCHOOL : Herricks High School

FINALISTS : Yusung John Lim

COUNTRY : United States

ABSTRACT

As electronics continue to shrink in size, the cost and environmental impact of current methods of production are increasing dramatically. The purpose of this experiment was to lay the groundwork in another potential method of creating nanowires and printed circuit boards. We believe that through the exposure of supercritical CO_2, metalized electrospun fibers with gold nanoparticles will have increased conductivity. In addition, the adhesion of metal to polymer thin films can be controlled with a poly (ethylene oxide) (PEO) mask on both silicon and Kapton substrates.

This study found that a specific concentration of gold nanoparticles can make a solution of poly (methyl methacrylate) (PMMA) in chloroform that cannot be electrospun, spinnable. Scanning electron microscopy also confirmed that $scCO_2$ smoothes the surface of the fibers and makes them more uniform. EDX analysis also found that exposure to $scCO_2$ also removed all residues of solvent and cross-sectional transmission electron microscopy showed that the nanoparticles were conglomerated near the surface. In conclusion, $scCO_2$ and gold nanoparticles respectively enhanced the morphology of the fibers and made the electrospinning process more robust. Cross-sectional analysis also showed that the nanoparticles attracted the deposited gold into the fiber making prongs reach from the deposition into the fiber, but there was no test to quantify the adbesion. Using the spray bottle test, the gold still remained on wires. The resistivity of the micro wires was extremely close to that of gold creating resistances within hundreds of ohms over hundreds of micrometers of wires.

Thin Films masked with PEO were exposed to $scCO_2$ and metalized with gold or copper. Atomic force microscopy analysis shows unique crystallization formations of poly (capro lactone) (PCL) after $scCO_2$ exposure. ASTM standard peel tests determined that the process was successful with PCL thin films. On the Kapton samples, peeling patterns reversed when the thickness became too great to melt in $scCO_2$.+

Through perfecting these processes, the electronics industry can continue in its miniaturization while the environmental and monetary costs.

評語

本作品創作能力很強，研究程序很有層次，而內容亦完整，在學術與應用上皆具價值。是一件很好的作品。