MWCNT-PET Films Prepared by Solution Casting for Electronics Applications

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Most applications of carbon nanotubes (CNTs) in flexible electronics require that CNTs be well-adhered to an underlying substrate, which in most cases is a transparent polymer layer. Also, the CNT-polymer layer has to be electrically conductive, structurally flexible, mechanically stable and optically transparent. We report on a new method to prepare conductive and transparent films of multi-walled CNTs (MWCNTs) with excellent adhesion to flexible polyethylene terephthalate (PET) surfaces. Our method employs a solution casting process in conjunction with a post-processing treatment to form MWCNT-PET layers that are able to withstand Scotch-tape tests, and are highly stable in fluids and other environments, thereby showing potential for usage in a wide range of applications. Our results are a clear improvement over present-state-of-art which employs various methods to promote CNT-polymer adhesion including using organic binders[1], intermediate metal layers[2], and microwave irradiation[3], among others. The drawbacks with these methods include reduced electrical conductivity and optical transparency.

In our approach, a clean PET sheet is placed on a hot plate surface at an elevated temperature such that the temperature of PET sheet is 90 – 100 °C. An aqueous dispersion of 0.1 wt% MWCNTs in 0.5 wt% Triton X-100 aqueous solution is subjected to ultrasonic sonication, and then cast on the hot PET sheet. This is followed by thermal curing on the hot plate at 90 – 100 °C for 1 hour. In a post-processing step, the MWCNT-coated PET sheet is immersed in a 70% nitric acid solution at room temperature for 5 minutes. This acid treatment results in the partial embedding of MWCNTs in the PET matrix, thereby resulting in high adhesion between MWCNT and PET, as evinced by Scotch-tape tests (Figure 1). We have been able to achieve MWCNT-PET layers with sheet resistance as low as 300 Ω/□. We have also achieved optical transparency as high as 80%, depending on the thickness of the MWCNT coating. We are now evaluating the MWCNT-PET films in multiple applications including a flexible optoelectronic device, a supercapacitor and a surface enhanced scattering chemical sensor.

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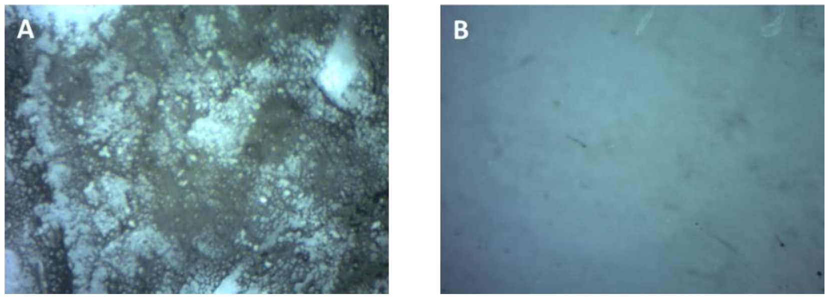

Figure 1: Optical images showing (A) the adhesive side of a Scotch tape after peeling off from a MWCNT-PET film which was not post-treated in acid; (B) the adhesive side of a Scotch-tape after peeling off from a MWCNT-PET film that was subjected to post-processing acid treatment, resulting in partial embedding of the MWCNTs in the PET matrix.