Improving the Adhesion of Single-Walled Carbon Nanotube Coatings on Plastic Substrates

Ana Santidrián
Olga Sanahuja, Ana Benito, Wolfgang Maser, Alejandro Anson-Casaos.

Instituto de Carboquímica (ICB-CSIC), Miguel Luesma Castán 4, 50018 Zaragoza, Spain.

asantidrian@icb.csic.es

Single-Walled Carbon Nanotubes (SWCNTs) display remarkable structural and physical properties, making the SWCNT transparent conducting films candidates to replace ITO and for other applications in electronics, energy and sensors[1]. In order to avoid structural damages, a good adhesion of the SWCNTs to the substrate needs to be guaranteed.

In this work, SWCNTs were spray-coated on plastic flexible substrates and a simple immersion treatment method was applied to improve the adhesion of SWCNTs[2]. The acid dipping treatment is used with acetate substrate, which is transparent and surface sensitive to oxidative acid treatments. Besides, a modified dipping treatment was also used for a chemically inert substrate, polyvinylidene difluoride (PVDF), with excellent results.

Therefore, it is confirmed that the immersion treatment is an appropriate tool for improving the adhesion of SWCNTs on plastic substrates. In the present report, apart from extending the dipping SWCNT films to improve the adhesion on multiple substrates, we provide a comprehensive picture of the immersion treatment influence by various methods of characterization.

The films were characterized by transparency and resistivity measurements. FESEM, AFM and Raman Spectroscopy techniques were used to study the morphological and structural changes arising from the immersion treatment. Direct evidence of the adhesion improvement was performed by the peel-off tape test (Figure 1). Additionally, a scratch test was performed in order to study the SWCNT coating resistance.

It was found that the SWCNT were embedded into the plastic substrates and the best adhesion was achieved upon treating the SWCNT-Acetate and the SWCNT-PVDF films with nitric acid (HNO_3) and N-Methyl-Pirrolidone (NMP), respectively. Thus, we present the achievement of SWCNT flexible, transparent and conductive films with excellent adhesion.

References

[1] H. Linxiang, C. Tjong, Materials Science and Engineering: R: Reports, 109 (2016) 1.

[2] S. Azoubel, S. Magdassi, ACS Appl. Mater. Interfaces, 6 (2014) 9265.

Figures

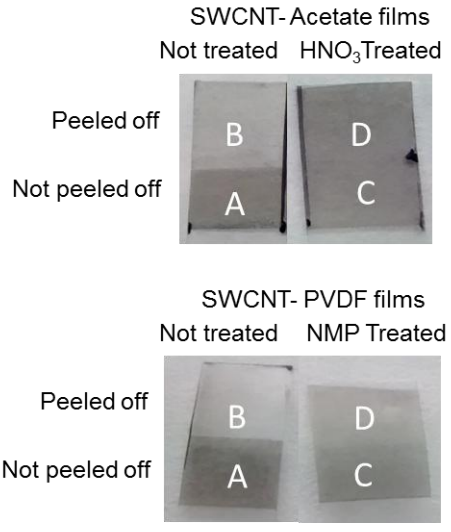

Figure 1: Effect of HNO_3 and NMP treatment on SWCNT-Acetate and SWCNT-PVDF films, respectively. Pictures of the films **A**- Not immersion treated and not peeled off. **B** - Not immersion treated and peeled off. **C**- Immersion treated and not peeled off. **D** - Immersion treated and peeled off