Preparation and Electric Properties of Polyimide / Carbon Nano Tube Hybrid Materials Prepared from Water Soluble Precursors

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Carbon nano tube (CNT) attracts much attention today due to its fantastic characteristics today. CNT / polyimide hybrid materials may be of interest because they offer thermal stable and strong films containing CNT, which can be applied to optical devices, packages, conductive belts and so on. CNTs are usually dispersed into a matrix from aqueous suspension, while conventional polyimides nor polyamide acids are not soluble in water. We have reported that addition of some amines to polyamide acid makes the resulting poly(amide acid ammonium salt) soluble in water due to ionic interaction. Thus PI/CNT hybrid materials were prepared by mixing CNT into water soluble polyamide acid ammonium salt aqueous solution, followed by thermal imidization.

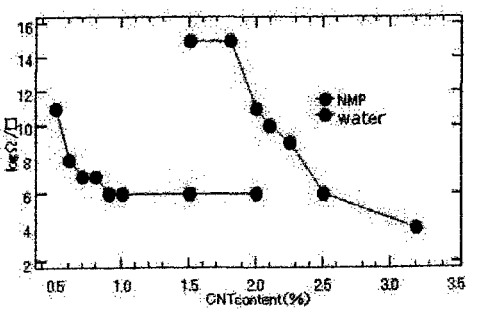

Figure 1 Surface resistance of PI/CNT hybride materials prepared from aqueous solution (●) and from NMP solution (●)

Fig 1 shows the surface resistance of resulting CNT/PI hybrid prepared from aqueous solution with water soluble polyimide precursor, and from NMP solution with conventional poly amide acid as the function of CNT content. The log Ω/□ reaches to 10^4 for the hybrid from aqueous solution, which is more conductive than that from NMP by the magnitude of 100, showing conductive network formation of CNT in PI, due to high miscibility using water as the mixing matrix.

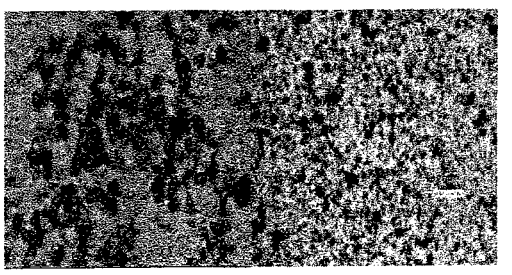

Figure 2 Optical micrograph of PI/CNT hybride prepared and from NMP solution (left) from aqueous solution (right)

Fig 2 shows the optical micrograph of PI/CNT hybrid materials. Deposit of large cluster is observed for the hybrid from NMP solution, while that from aqueous solution is relatively homogenous.

These materials are expected to be applied utilizing CNT feature and reliable PI nature.

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In this work, we extended candidate of water-soluble polymer to polyimide, which is known as a super engineering plastic. Conventionally polyimides are not soluble in water in the final polyimide forms nor in the precursor polyamic acid (PAA) forms. In our approach we made a polyamic acid soluble in water by adding triethanolamine as shown in Fig. 1.[1]

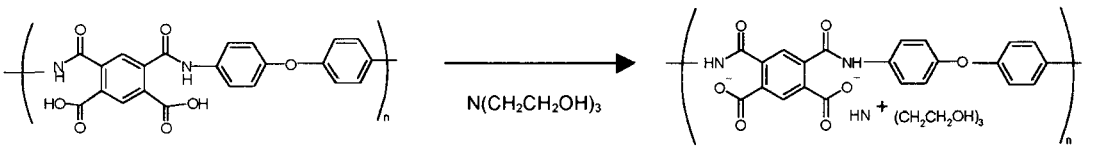

Fig. 1. Water-soluble PAA by addition of triethanolamine

CNT (CNI, X-grade) are sonicated in water with addition of a nonionic surfactant Triton X-100 with a strong ultrasonicator (Tosho Denki, Nano-Raptor), and mixed with the PAA water solution. The mixed solution was then cast on flat glass and heat-cured for imide conversion. Surface resistivity of the so-prepared films showed a drastic change at around 2 wt% concentration, indicating the formation of conductive networks by CNT.