THE EFFECTS OF IRRADIATION MODIFICATION ON THE FLOATING CARBON NANOTUBE FILM

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ABSTRACT

As a two-dimensional self-supporting macroscopic scaffold of carbon nanotube (CNT), CNT film fabricated by the method of floating catalytic chemical vapor deposition (FCCVD), which is called floating CNT film for short, has a porous network structure formed by overlapped CNTs. Excluding the processes of dispersion and solution filtration, floating CNT film can avoid the problem of CNT random agglomeration and CNT damage effectively, which enable the film higher CNT content, less impurities and better property-transferring of single CNT. Furthermore, floating CNT film possesses low density, tunable CNT orientation, impressive flexibility, outstanding mechanical properties and functional properties, such as the tensile strength up to 9.6 GPa[1], the electric conductivity of 2.27 × 10^4 S/cm[2], the thermal conductivity of 766 W/m·K[3], making it a potential material in the fields of energy, transistor and electronic component, electromagnetic shielding and so on[4, 5]. Good mechanical behavior is the basis for the multifunctional application of materials, thus it has always been a research focus to improve the mechanical properties of CNT films or fibers. Being different from the common modification approaches presented during the past ten years, such as acidification, adding polymer, stretching and pressing, this paper makes a novel attempt to enhance the floating CNT film by irradiation and investigates influences of some process factors on the film's mechanical and electrical properties. To be detailed, firstly, ultraviolet irradiation was applied on the floating CNT film, and the film properties under various irradiation time and pre-treatment were tested and compared. As shown in Fig 1a, it is indicated that the tensile strength shows a growing intendancy as the irradiation time increases, while the electrical conductivity has a reverse change. After being ultraviolet irradiated for 6 h, the tensile strength is improved from 96 MPa to 145 MPa by 51%, but the electrical conductivity is decreased to 626 S/cm which is only 84.5% of the original value. Besides, a DMF-dipping pre-treatment is also applied, which can promote the increase of tensile strength, reduce the influence of irradiation time and the decline of electrical conductivity (Fig 1b). Secondly, electron beam irradiation was executed on the floating CNT film in cooperation with some other treatment including acid-wash or annealing. As in Fig 2, it is proved that both of the acid-wash and annealing can improve the tensile properties of floating CNT film at different level, but the electron beam irradiation doesn't show significant influence. As a novel attempt, this work is considered to provide some new study routes and reference research experiences for the properties enhancement of CNT film.

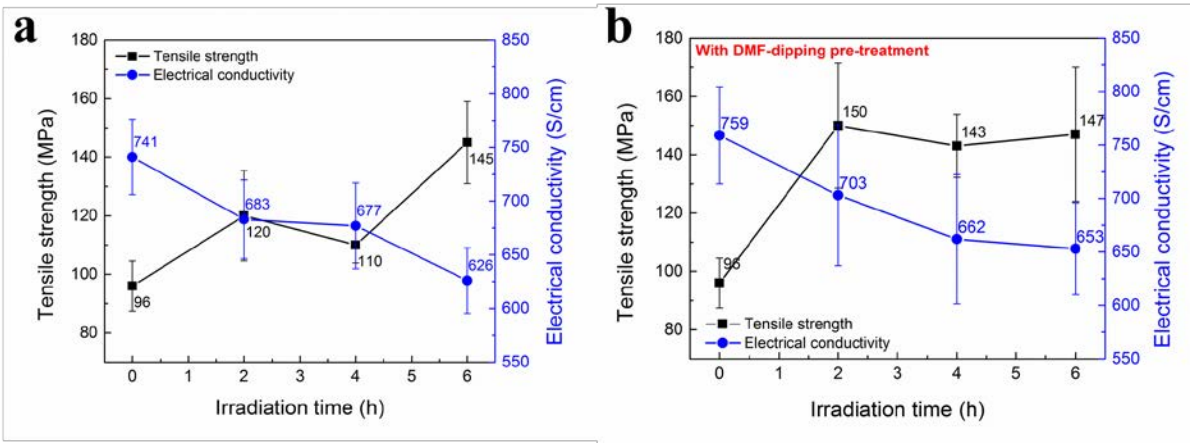

Figure 1. The tensile strength and electrical conductivity of (a) CNT film and (b) DMF-dipping pre-treated CNT film ultraviolet-irradiated by different time.

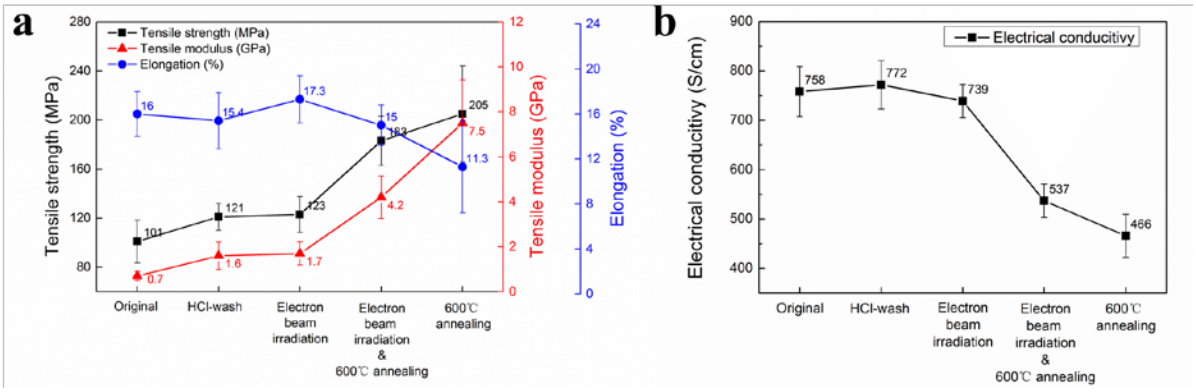

Figure 2. (a) The tensile properties and (b) electrical conductivity of CNT film treated by different methods.

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