The effect of acid treatments on the conductivity of spin-capable carbon nanotube

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Transparent conductive films (TCFs) which have both low resistivity and high transmittance have been widely used as components of electronic applications. Indium tin oxide (ITO) is the most popular material for TCFs due to its high optical transmittance (> 90%) and low electrical resistance (< 100 Ω/sq). However, ITO has serious limitations such as the necessity of high vacuum processing for deposition, an increasing raw material price due to limited supply, a fragile nature, and a high refractive index. [1] Therefore, new candidate materials are necessary to replace ITO.

Spin-capable carbon nanotubes (CNTs) are proposed as a promising material for (TCFs) to replace ITO in optoelectronic and flexible applications. As shown Fig. 1, CNT-TCFs were prepared by a dry-spun method, a straightforward transfer process for fabricating CNT-based films. [2] These CNT sheets had sheet resistances of 0.75–1 kΩ/sq and transmittances of ~80%.[3] Generally, sheet resistances of 0.5 kΩ/sq and transparency of about 80% are required in organic electronics and touch panel electrodes. [4] Thus, further improvements must be conducted to satisfy the industrial requirements of practical applications based on CNT-TCFs.

In this paper, we present new efforts to reduce sheet resistance of the CNT film using simple acid treatments. Two different acid treatments were carried out to determine an efficient treatment process. One CNT film was continuously immersed in a nitric acid solution, while the other was immersed in the acid solution for 1 h followed by exposure to fuming nitric acid. We found that adding fuming acid treatment after immersion treatment is an efficient way to obtain high conductivity CNT films.

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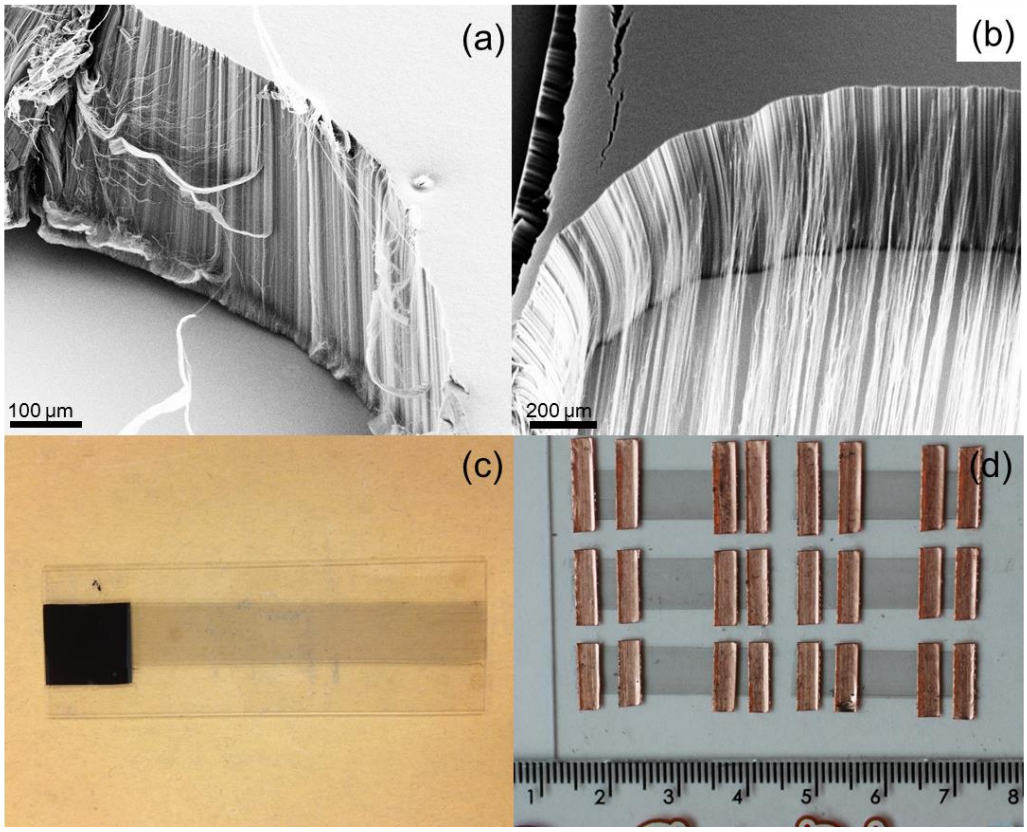

Figure 1: High resolution SEM images of (a) the CNT forest, (b) CNT film pulling from the CNT forest, (c) transfer of the film from a Si substrate to glass substrate, and (d) transferred CNT films prepared for electrical and optical characterizations.