Direct observation of structural change in Au-incorporated carbon nanofibers by current-induced annealing

Nagoya Inst. of Tech.[1], Univ. Pend. Sultan Idris[2], Univ. Putra Malaysia[4], Univ. Tech. Malaysia[3]

°Mohamad Saufi Rosmi[1, 2], Yazid Yaakob[1, 3], Subash Sharma[1], Mohd Zamri Mohd Yusop[4], Golap Kalita[1], Masaki Tanemura[1]

E-mail: saufirosmi@gmail.com

Over a past few decades, carbon nanotubes (CNTs) have attracted much attention for their unique properties. In the chemical vapor deposition (CVD) of CNTs, metal particles incorporated into CNTs are limited to catalyst metals, which are usually transition metals, such as iron (Fe), nickel (Ni), and cobalt (Co). There have been only a few reports on noble metals such as gold (Au) as catalysts, owing to their low carbon solubility. Recent advances in *in situ* transmission electron microscopy (TEM) techniques now open up the new possibility of studying solid phase interaction at atomic level [1]. Here, we report the direct observation of Au-incorporated carbon nanofiber (Au-CNF) structural transformation to CNTs by *in-situ* TEM.

In our approach, Au-CNF was grown on the edge of graphite foil by ion irradiation of Ar^+ at room temperature [2]. Au-CNF then was mounted on cathode microprobe and bamboo-like CNTs formation was investigated during current-voltage (I-V) measurement. TEM images revealed that the Au-CNF was amorphous and polycrystalline in nature initially, and the current flow in I-V process induced the dramatic change in the crystalline structure of CNF; formed bamboo-like CNTs. The Au metal nanoparticles agglomerated and then evaporated due to joule heating during the I-V process, resulting in the crystalline bamboo-like CNTs structure. We observed structural deformation and breaking of the CNTs with a higher applied voltage, attributing to saturated current flow and induced Joule heating.

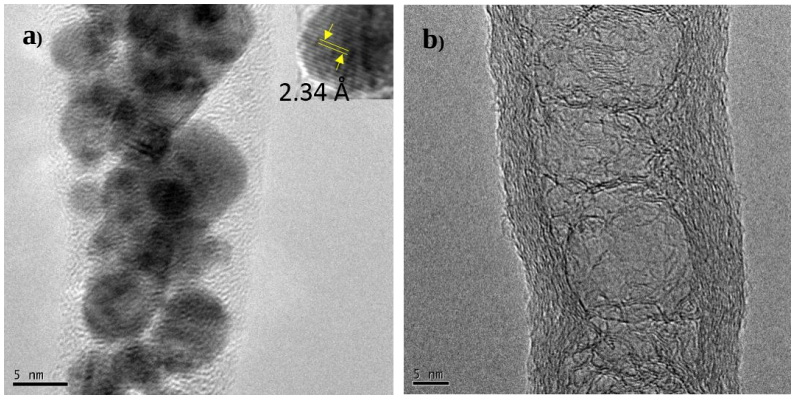

Fig. 1 (a) TEM image of (a) Au-CNF before current flow, (b) bamboo-like CNTs formed after current flow.

References:

[1] M. Zamri, et al., ACS Nano: 6 (2012), 9567-9573.

[2] C. Takahashi, et al., Carbon: 75 (2014) 277-280.