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A Minute Amount of Noble Metals Added into Iron Catalyst Enabling the Highly Efficient Synthesis of Single-walled Carbon Nanotube Forest without Reducing Gases

Abstract

Pre-annealing iron thin film in reducing gases such as hydrogen (H_2) are one of the common factors in most of the previous reports preparing the catalyst suitable for the synthesis of tall single-walled carbon nanotube (SWNT) forest [1,2]. To study the fundamental requirement for the preparation of active catalyst, we survey the effect of metal composition of catalyst materials. Here, we report a minute amount (< 0.5 at%) of noble metals (NM = iridium, rhodium, and platinum) added into iron catalyst unexpectedly enabled a highly-efficient synthesis of tall (>600 μm) CNT forests without any reducing gases. Raman and TEM analyses suggested that those CNT forests mainly composed of SWNT. X-ray photoelectron spectroscopy (XPS) analyses on the catalyst films suggested that NM addition invoked the reduced oxidation states of iron atoms in prior to SWNT synthesis. This work was supported by JSPS KAKENHI Grant Number JP17K14090.

References

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- [2] S. Sakurai, H. Nishino, D. N. Futaba, S. Yasuda, T. Yamada, A. Maigne, Y. Matsuo, E. Nakamura, M. Yumura, and K. Hata, *J. Am. Chem. Soc.*, 134 (2012) 2148.

Figures

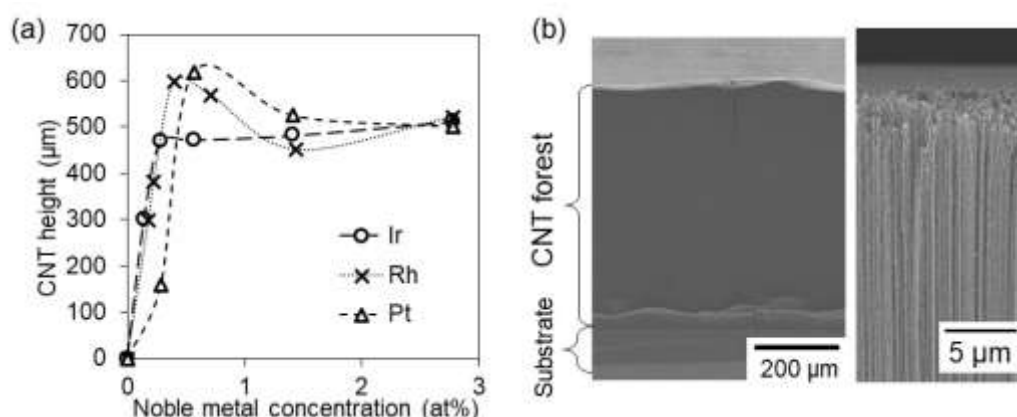


Figure 1: (a) Height of CNT forest (Grown within 10 minutes) vs Atomic concentrations of noble metal (Circle: Iridium, Cross: Rhodium, Triangle: Platinum) added into iron catalyst. (b) SEM images of CNT forest from Rh 0.4 at% catalyst. (inset: Photograph from top of the forest).