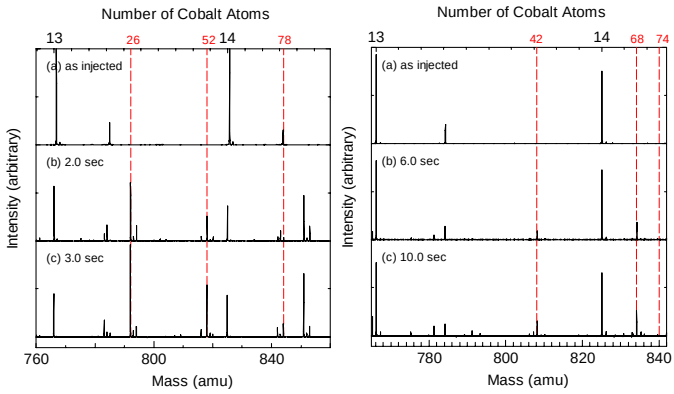
FT-ICR Study of Reaction of Cobalt Clusters with Alcohol, Ether and Hydrocarbon

○ Daisuke Yoshimatsu, Kohei Koizumi, Naoki Suyama and Shigeo Maruyama

Department of Mechanical Engineering, The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8656, Japan

SWNTs are expected for various applications for extraordinary physical and chemical characters based on the unique geometric structure. As for the macroscopic generation, the ACCVD technique appears to be one of best synthesis methods [1]. However its synthetic mechanism has not yet been made clear, hence the fundamental research is necessary for generation of better quality SWNTs. In order to investigate the initial reaction of alcohol or hydrocarbon with a metal nano-particle, we have been studying the chemical reaction of transition metals clusters by FT-ICR (Fourier Transform Ion Cyclotron Resonance) mass spectrometer with laser-ablation supersonic-expansion cluster beam source [2]. Our previous FT-ICR studies have compared the reactivity of Fe, Co, and Ni clusters with ethanol. The dehydrogenation process on Co clusters was studied in detail by using isotopically modified ethanol. The dehydrogenation reaction was observed only in the limited size range of Co clusters i.e. Co_{12} ~ Co_{17}. On the other hand, all the tested Ni clusters tested always showed immediate dehydrogenation reaction, whereas such reaction was not observed for Fe clusters. Among these transition metals, cobalt clusters are studied to gain better insights on the initial reaction of catalysts with carbon containing molecules.

In this paper, we have explored the basic reaction mechanisms of relatively large catalyst clusters of cobalt with ethanol, methane, ethylene and diethyl ether which are commonly used as carbon source for SWNTs generation. Fig. 1 shows mass spectra of reaction of cobalt clusters with ethylene and diethyl ether (RT, 1×10^{-8}torr). For ethanol, ethylene and diethyl ether, the dehydrogenation reactions were observed. Furthermore, not only one molecule, but a few molecules adsorption to cobalt clusters were observed.



(a) Ethylene (b) Diethyl ether

Fig. 1. FT-ICR mass spectra of reaction of Co clusters with (a) ethylene, (b) diethyl ether.

References

[1] S. Maruyama et al., Chem. Phys. Lett., 360 (2002) 229.

[2] S. Maruyama et al., Rev. Sci. Instrum., 61 (1990) 3686.

Corresponding Author: Shigeo Maruyama

Fax: +81-3-5800-6983 E-mail: maruyama@photon.t.u-tokyo.ac.jp