

Surface reactions of Fe on SiO₂ thin layer/Si substrates studied by SPELEEM

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The electronic properties, such as the band gap, depend on the chirality of carbon nanotubes (CNTs), and the metal catalyst significantly contributes to the determination of the CNT structure during CVD growth. Therefore, we have been investigating the reactions between the substrate and catalysts^{1,2}. Thus far, we have found that the silicidation temperature of Fe is about 100°C higher than that of Co¹. The mass-transport of Fe is therefore expected to differ from that of Co². This would be important for position control of CNTs and was investigated using SPELEEM.

The experiments were performed at BL-27SU/SPring-8. We used Si(001) substrate, on which a 1.8-nm-thick SiO₂ layer was formed. Voids, a clean surface area, were formed and a 10 ML of Fe was deposited on the substrate. Figure 1 shows a typical PEEM image and Fig. 2 shows Fe L-edge XAFS spectra obtained from the (a) oxide area, and (b) void area. Fig. 2 (a) shows that metallic Fe transformed to silicide at 720°C in the oxide areas. In the void areas, the spectra changed gradually, indicating that metallic Fe transformed into various silicides, such as FeSi and α -FeSi₂. Meanwhile, the intensity of the XAFS edge jump in the oxide area decreased in the temperature range between 600 and 700°C, which is 100°C higher than the case of Co². In the void areas, the intensity decreased with increasing substrate temperature. These results show that, in contrast to Co, Fe at the surface decreases even in the form of silicides, suggesting that the path of Fe diffusion into Si substrates differs from that of Co.

References: 1. F. Maeda, et al., *Physica E*, **24** (2004) 19. 2. F. Maeda, et al. *e-Journal of Surface Science and Nanotechnology*, **4** (2006) 155.

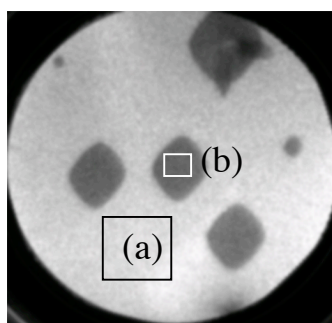


Fig. 1. PEEM image. Field of view was 30 μ m and excitation photon energy was 707.8 eV.

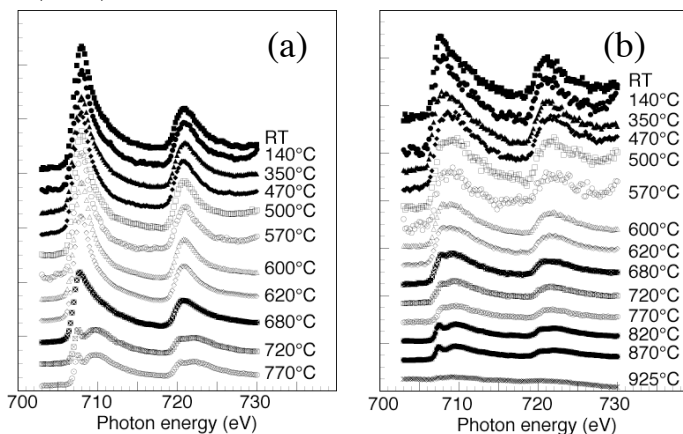


Fig. 2. XAFS spectra obtained from selected areas (a) and (b).