Electrochemical formation of Ni-Si alloys for the application as anode-materials in lithium-ion-battery

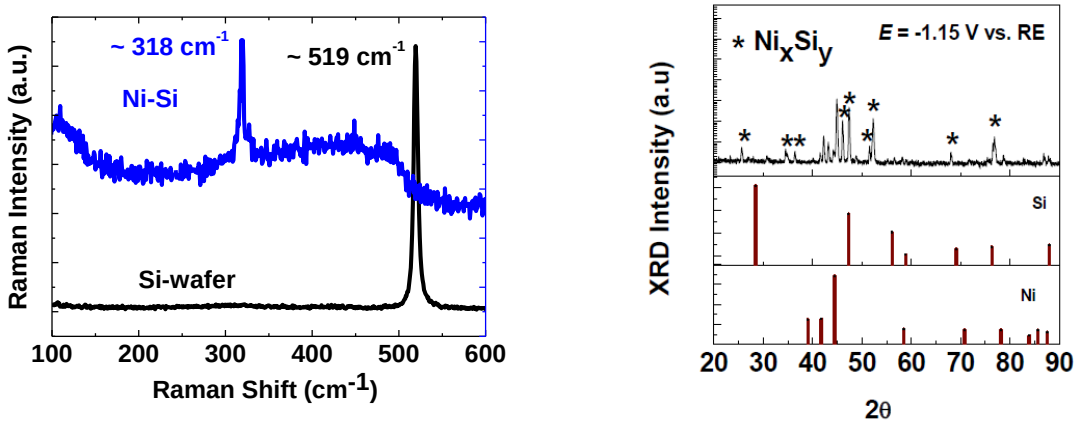
筑波大学[1], Univ. Tunis-El-Manner[2], 国立研究開発法人物質・材料研究機構[3] ○ Muhammad Monirul Islam[1], Said Hajer[1,2], Imane Abdelloui[1], 秋本 克洋[1], Ahmed Hichem Hamzaoui[2], 深田 直樹[1,3], 櫻井 岳暁[1]

Tsukuba Univ. [1], Univ. Tunis-El-Manner[2], NIMS[3] ○ Muhammad Monirul Islam[1], Said Hajer[1,2], Imane Abdelloui[1], Katsuhiro Akimoto[1], Ahmed Hichem Hamzaoui[2], Naoki Fukata[1,3], Takeaki Sakurai[1]

E-mail: islam.monir.ke@u.tsukuba.ac.jp

Recently silicon (Si)-based materials with highest-known theoretical charge capacity of 4200 mAh/g, have been considered as promising anode materials in lithium-ion battery (LiB). Specially, Si-metal based (Carbon, nickel, iron etc.) nano-composites have drawn particular attention as it can effectively suppress volume expansion due to free space surrounding the nano-structures, and thus improve life cycle of the LiB. In this paper, we have reported a low-cost electrochemical route for the formation of Ni-Si based alloys on Ni-substrates obtained through electrochemical reduction of silica powder (SiO_2).

Electrodeposition of Ni-silicides has been carried out in a Al_2O_3- crucible placed inside a quartz electrochemical cell equiped with three-electrode system. Graphite has been used as counter electrode (CE) as well as reference electrode (RE), while Ni-sheet was used as the working electrode (WE) as well as substrate for



(a) (b)

Fig. 1 (a). Room temperature Raman spectra of electrodeposited Ni-Si layer deposited with potential, E = -0.75 V vs. graphite RE; (b) X-ray diffraction (XRD) pattern of electrodeposited Ni-Si layer.

the electrodeposition. Electrochemical analysis has been done under Ar-gas at 860^{O} Celsius using $CaCl_2$ molten salt. Chronoamperograms (CA) has been done at constant potential (E) applied between Ag-substrate (WE) and graphite reference electrode. Cyclic voltammetry (CV), and all the constant potential electrolysis were carried out with an HSV-110 potentiometer (Hokuto Denko, Japan).

Fig. 1 (a) shows Raman spectra of an electrodeposited Ni-Si layer on Ni-substrate deposited with potential, E = -0.75 Volt, applied between the Ni-substrate and Graphite-RE. A peak around ~ 318 cm^{-1} together with appearance of broadened peaks in between 350~ 500 cm^{-1} suggest formation of Ni-Silicides on the Ni-substrate. X-ray diffraction (XRD) pattern (Fig. 1 (b)) also supports formation of Ni-Si alloys on Ni-substrate. Optical and structural properties of the electrodeposited Ni-Si layers will be studied in relation to the effect of various reduction potential applied during electrochemical reduction of SiO_2 and discussed.