In Situ Spectromicroscopic Study of Nickel Induced Lateral Crystallization of Amorphous Silicon Thin Film Using SPESM

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The crystallization of amorphous silicon (a-Si) has been a subject of research, because ploycrystalline silicon (poly-Si) thin film has been a key material for flat-panel displays, organic light-emitting diodes, solar cells, and so on. As poly-Si thin film transistors (TFTs) should be made on inexpensive glass substrates for the low fabrication cost, it is indispensable to decrease the crystallization temperature of a-Si films as low as possible. One of the most effective methods lowering crystallization temperature is metal induced lateral crystallization (MILC). Thus, various MILC methods have been proposed to shorten the thermal annealing time and lower the process temperature.[1-4] However, little is known about the chemical interaction of the patterned metal film with a-Si substrate during MILC process. Therefore, analytical probes with high sensitivity to identify spatial variations of the surface compositions during chemical reactions of MILC are in extreme demand. Scanning photoelectron spectromicroscope (SPESM) is a powerful instrument for quantification and mapping of complicated morphological surfaces with high spatial resolution, elemental sensitivity, and chemical-state speciation, which is based on x-ray photoemission spectroscopy (XPS) imaging with 0.1-μm resolution.[5,6] Thus, with chemical and spatial sensitivity on the sub-micrometer scale, the lateral formation of poly-Si induced by metal in a-Si film can be analyzed by a straightforward technique.

In our report, the lateral chemical variations of a-Si thin film induced by the patterned Ni pads was studied in detail, performing *in situ* vacuum annealing experiments with SPESM. Lateral variations in the local chemistry of the Ni-MILC of a-Si were directly imaged. High-resolution photoemission measurements on the Si *2p* and Ni *3p* core leves and valence band were used to evaluate morphological changes and interfacial reactions. Results indicate that the Ni-MILC process in UHV leads to the lower crystallization temperature as well as the fast crystallization speed of a-Si, and a poly-Si film with the best crystallinity is laterally grown over ~ 20 μm at 500ºC for 1 hour.

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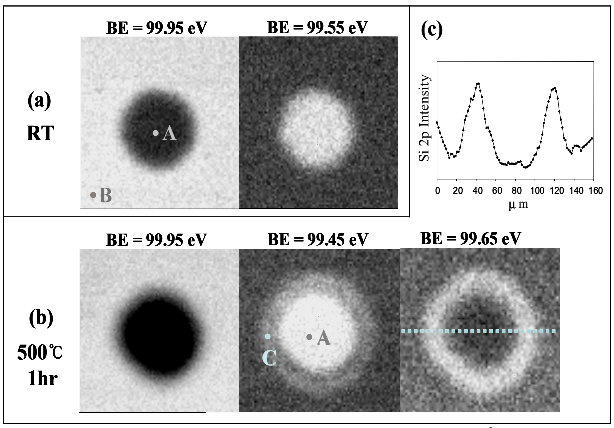

Figure 1. Chemical state maps (160 × 160 μm^2) of Si *2p* photoelectrons at different kinetic energies from a Ni circle pad on a-Si, obtained at RT (a) and after in-vacuum heating at 500℃ for 1 hr. (b), respectively. (c) Si *2p* intensity profile taken across the MILC region.

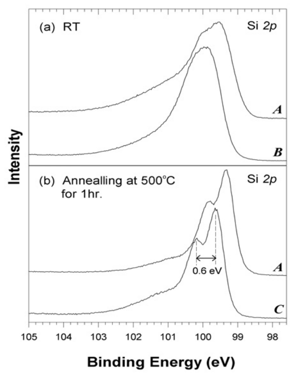

Figure 2. High-resolution μ-XPS of Si *2p* core electrons from different regions of ***A***, ***B***, and ***C*** indicated in Fig. 1(a) and (b), taken at RT (a) and after annealing at 500℃ for 1 hr. (b) , respectively.