분과초청6

Characterization of carrier transport and trapping in semiconductor films during plasma processing

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The carrier transport is a key factor that determines the device performances of semiconductor devices such as solar cells and transistors [1]. Particularly, devices composed of in amorphous semiconductors, the transport is often restricted by carrier trapping, associated with various defects. So far, the trapping has been studied for as-grown films at room temperature; however it has not been studied during growth under plasma processing. Here, we demonstrate the detection of trapped carriers in hydrogenated amorphous silicon (a-Si:H) films during plasma processing, and discuss the carrier trapping and defect kinetics.

Using an optically pump-probe technique, we detected the trapped carriers (electrons) in an a-Si:H films during growth by a hydrogen diluted silane discharge [2]. A device-grade intrinsic a-Si:H film growing on a glass substrate was illuminated with pump and probe light. The pump induced the photocurrent, whereas the pulsed probe induced an increment in the photocurrent. The photocurrent and its increment were separately measured using a lock-in technique. Because the increment in the photocurrent originates from emission of trapped carriers, and therefore the trapped carrier density was determined from this increment under the assumption of carrier generation and recombination dynamics [2].

We found that the trapped carrier density in device grade intrinsic a-Si:H was the order of 1e17 to 1e18 cm-3. It was highly dependent on the growth conditions, particularly on the growth temperature. At 473K, the trapped carrier density was minimized. Interestingly, the detected trapped carriers were homogeneously distributed in the direction of film growth, and they were decreased once the film growth was terminated by turning off the discharge.

REFFERENCE

[1] S. Nunomura, X. Che , and S. R. Forrest, Adv. Mater. 26, 7555 (2014).
[2] S. Nunomura , I. Sakata , AIP Adv. 4, 097110 (2014).
[3] S. Nunomura , I. Sakata , M. Kondo, Appl. Phys. Express. 6, 126201 (2013).

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