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In-situ measurements of carrier transport and trapping in semiconductor films during plasma processing

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In semiconductor devices, carrier transport is an important factor that determines the device performances [1]. It is often limited by carrier trapping, related to various defects and/or transport barriers. So far, the transport and trapping phenomena have been studied for as-deposited films; however they have not been studied during plasma processing. In the presentation, we demonstrate in-situ measurements of carrier transport and trapped carriers in hydrogenated amorphous Si (a-Si:H) under plasma processing.
Using an optically pump-probe technique, we measured the photocurrent in an a-Si:H films during growth by a hydrogen diluted silane discharge [2]. The photocurrent was induced by the pump illumination, and it was slightly increased when the probe light was superimposed. This increase originates from emission of trapped carriers. Thus, we evaluated the carrier transport via the photocurrent measurement, and the trapped carrier density from the increase in the photocurrent induced by the probe.
We observed that the photocurrent gradually increased as the film grew with time. Such a time evolution suggests a defect-rich surface layer in the early stage of growth and a bulk layer growth at a later stage [3]. Interestingly, the photocurrent was significantly increased once the film growth was terminated, indicating the defect relaxations during postgrowth annealing. For carrier trapping, we found that trapped carriers were homogeneously distributed in the growing film, and their density was ~1018 cm-3 at an pump light intensity of 10mW/cm2.
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Keywords
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