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POS-15 Digital photocorrosion of GaAs/AlGaAs: a quest for fabrication of defect-free III-V nanostructures

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Instability of GaAs and AlGaAs in an aqueous environment increases drastically following illumination with photons of energy exceeding bandgap of these materials. We have investigated the dynamics of photon-induced dissolution of GaAs/AlGaAs nano-heterostructures in deionized water (DI H2O) and ammonium hydroxide (NH4OH) environments by employing inductively coupled plasma mass spectrometry (ICP-MS). The samples were irradiated with a 660 nm light-emitting diode delivering 16 or 20 mW/cm2 of a uniform radiation and their photocorrosion was monitored in situ with the photoluminescence effect. Consistent with the calculated concentrations of ions released by dissolving GaAs/Al0.35Ga0.65As nano-heterostructures up to approximately 60 nm thick, the ICP-MS results confirmed the expected presence of As3+ ions in the photocorrosion products. Some accretion of Ga2O3, Al2O3 and Al(OH)3 has been observed on the surface of thicker samples, as evidenced by the Fourier transform infrared absorption spectroscopy, X-ray photoelectron spectroscopy and atomic force microscopy data. These results have been corroborated by the ICP-MS analysis that revealed reduced concentrations of As3+ and Ga3+ ions released to the photocorrosion product by nano-heterostructures thicker than ˜ 60 nm. The photocorrosion in NH4OH environment allowed to alleviate, partially at least, the problem of an excessive accumulation of oxides. We discuss the conditions that needs to be met to allow digital photocorrosion of GaAs/Al0.35Ga0.65As nano-heterostructures thicker than 100 nm.

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