Growth Strategies for Modifying Heterovalent Interfaces

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Integration of dissimilar semiconductor materials is becoming an increasingly important pathway for pushing the boundaries of device performance by expanding the options for material selection. The major challenge that must be overcome is the formation of interfaces between two materials with different valences. Charge imbalances arising at interfaces between conventional semiconductors are often alleviated through re-distribution of atoms, which can lead to intermixing-induced degradation of the adjoining layers.

Here, we show that a combination of elemental treatments combined with UV photon exposure can be used to tailor the properties of model ZnSe/GaAs interfaces formed by molecular beam epitaxy. X-ray diffraction and photoluminescence were used to assess the interface roughness and degree of intermixing. Treatment of an As-terminated GaAs surface with UV light and a Se flux results in both an abrupt interface and passivation of the underlying GaAs epilayer. We propose that this improvement over interfaces grown under dark conditions and treatment with a Zn flux is triggered by light-induced desorption of As atoms followed by enhanced Ga-Se bond formation [1]. Thus, the combination of light and elemental treatment during interface initiation offers a highly tunable approach to significantly alter interface properties.

[1] K. Park and K. Alberi, Scientific Reports, 7, 8516 (2017)

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Supplementary Page

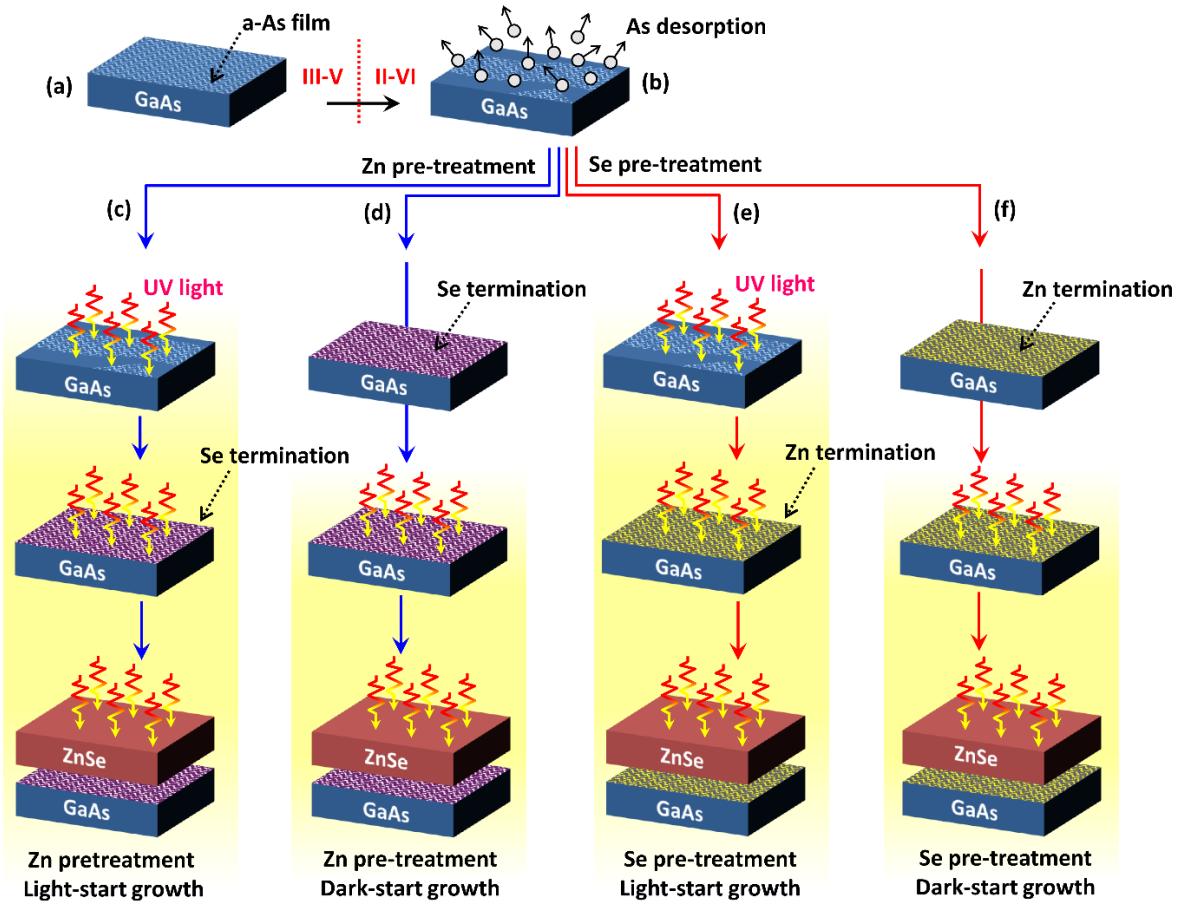

Figure 1. Schematic of the interface initiation processes that were explored. (a) GaAs epitaxial layers were grown on (001) GaAs substrates in our III-V molecular beam epitaxy (MBE) chamber. The surface of the GaAs epitaxial layer was covered with amorphous arsenic film prior to transferring the sample to our II-VI growth chamber. (b) The amorphous arsenic film was thermally desorbed to establish an As-terminated GaAs surface, and the surface exposed to Zn or Se, as shown in (c)-(d) and (e)-(f). Growth of the ZnSe epitaxial layer was initiated either with a Zn or Se exposure and with or without UV light irradiation.