CARRIER TRANSPORT PROPERTIES, SPECTRAL PHOTORESPONSE, AND BANDGAP STRUCTURE FEATURES IN pnn^+-GaAs WITH PATTERNED NANOSCALE As_2O_3–GaAs INTERFACE

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S u m m a r y

An advanced patterned As_2O_3—pnn^+-GaAs structure has been examined by the current-voltage characteristics (IVC), photoresponse (PR) spectral measurements, SEM image study, X-ray analysis, and electroreflectance (ER) spectroscopy for a novel optical design and the observation of transport phenomena. The patterned semiconducting medium has been developed simultaneously with the arsenolite oxide phase of As_2O_3 by anisotropic chemical etching (ACE) in a $(10 \div 15)N$ HNO_3 solution at the p-type top surface of the pnn^+-GaAs structure. This medium is found to consist of the skeleton-dendritic morphology with a size of about 5–10 μm covered by chemisorbed nanoscale As_2O_3 and non-stoichiometric layers with Ga vacancies and free As at the interface As_2O_3–GaAs. It is shown that, under favourable patterning conditions, the inversion layer near a surface with triangular potential well of a variable width from 14 to 25 nm has been formed. In this case, the negative differential resistance (NDR) region with oscillation behavior and the peak-to-valley ratio (PVR) from 10 to 100, which is typical of a quantized structure, has been observed on dark forward (fw) I–V characteristic (IVC). Spectral data have shown the improving of the short-wavelength response as the long-wavelength one. The effect of a patterning regime on photovoltaic (PV) parameters is found as well. For a higher reverse (rv) voltage, the increasing of PR by up to 4 orders has been realized due to the avalanche multiplication. The photoresponse detection beyond the normal absorption edge of GaAs has been demonstrated because of the Franz—Keldysh effect.

A possible model of evolution of the skeleton-dendritic multilayer patterned As_2O_3—pnn^+-GaAs structure during ACE is proposed. The carrier transport mechanism and bandgap structure features have been discussed.