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Title:Ge/Si(001) heterostructures with dense arrays of Ge quantum dots: Morphology, defects, photo-emf spectra and terahertz conductivity

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Abstract:Issues of Ge hut cluster array formation and growth at low temperatures on the Ge/Si(001) wetting layer are discussed on the basis of explorations performed by high resolution STM and in-situ RHEED. Dynamics of the RHEED patterns in the process of Ge hut array formation is investigated at low and high temperatures of Ge deposition. Different dynamics of RHEED patterns during the deposition of Ge atoms in different growth modes is observed, which reflects the difference in adatom mobility and their 'condensation' fluxes from Ge 2D gas on the surface for different modes, which in turn control the nucleation rates and densities of Ge clusters. Data of HRTEM studies of multilayer Ge/Si heterostructures are presented with the focus on low-temperature formation of perfect films. Heteroepitaxial Si p-i-n-diodes with multilayer stacks of Ge/Si(001) quantum dot dense arrays built in intrinsic domains have been investigated and found to exhibit the photo-emf in a wide spectral range from 0.8 to 5 μ m. An effect of wide-band irradiation by infrared light on the photo-emf spectra has been observed. Photo-emf in different spectral ranges has been found to be differently affected by the wide-band irradiation. A significant increase in photo-emf is observed in the fundamental absorption range under the wide-band irradiation. The observed phenomena are explained in terms of positive and neutral charge states of the quantum dot layers and the Coulomb potential of the quantum dot ensemble. A new design of quantum dot infrared photodetectors is proposed. By using a coherent source spectrometer, first measurements of terahertz dynamical conductivity (absorptivity) spectra of Ge/Si(001) heterostructures were performed at frequencies ranged from 0.3 to 1.2 THz in the temperature interval from 300 to 5 K. The effective dynamical conductivity of the heterostructures with Ge quantum dots has been discovered to be significantly higher than that of the structure with the same amount of bulk germanium (not organized in an array of quantum dots). The excess

conductivity is not observed in the structures with the Ge coverage less than 8 Å; When a Ge/Si(001) sample is cooled down the conductivity of the heterostructure decreases. © 2012 Yuryev et al.

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