Electronic properties of thin GaP layers grown on silicon wafers

A.I. Baranov[1,2], A.S. Gudovskikh[1,3], I. A. Morozov[1], A. M. Mozharov[1], A.Darga[2,4], J.-P. Kleider[2]

[1] St Petersburg Academic University of RAS, St.-Petersburg, Russia.

[2] GeePs, Group of electrical engineering - Paris, CNRS, CentraleSupélec, Univ. Paris-Sud, Université Paris-Saclay Sorbonne Universités, UPMC Univ Paris 06, Paris, France.

[3] St Petersburg Electrotechnical University "LETI", St.-Petersburg, Russia.

[4] Sorbonne Universités, UPMC Univ Paris 06, UMR 8507, Paris, France.

Nowadays, growth of III-V compounds on silicon wafers is a challenge for many scientists in the world. The development of such technology is essential for new silicon photonic applications: optoelectronic integrated circuits, silicon based multijunction solar cells (SC). However, fabrication of photoactive GaP/Si heterojunction faces several technological problems that should be solved. The commonly used techniques for the growth of GaP on Si wafers as molecular beam epitaxy (MBE) and metal organic vapor-phase epitaxy (MOVPE) require high temperatures of 800-900°C, which leads to deterioration of the Si wafers and III-V/Si interface quality. First, difference in coefficients of thermal expansion of silicon and GaP leads to appearance of dislocation during the growth. Second, the usage of high temperatures leads to inter-diffusion of group-III and -V atoms into Si and opposite, which act as dopants affecting the electrical properties of heterojunctions. Recently, a new technological approach was proposed for the growth of GaP on silicon wafers by low-temperature plasma enhanced atomic layer deposition (PE-ALD) at temperature below 400 °C [1]. It is based on alternation of PH_3 (phosphine) and TMG (trimethylgallium) flows in PECVD chamber during the growth process.

In this work, we study thin GaP layers grown on silicon wafers at different conditions. The GaP layers of various thickness (20-200 nm) were grown at ALD and continuous PECVD modes. Also, flow of SiH_4 (silane) was used as a source of n-type dopant for GaP layers. Then, gold was deposited on GaP layers for formation of Schottky barriers (SB). Current-voltage characteristics and capacitance techniques (deep-level transient spectroscopy, capacitance-voltage) were used to study Au/undoped-GaP/n-Si and Au/n-GaP/n-Si heterostructures. The properties of the new low temperature GaP material grown under different conditions were explored.

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[1] I A Morozov, A S Gudovskikh, D A Kudryashov, E V Nikitina, J-P Kleider, A V Myasoedov, V Levitskiy. Thin film GaP for solar cell application // Journal of Physics: Conference Series 741 (2016) 012088