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A New Mechanism of Contact Resistance Formation in Ohmic Contacts to Semiconductors with High Dislocation Density — A.V. Sachenko[1], A.E. Belyaev[1], N.S. Boltovets[2], R.V. Konakova[1], Ya.Ya Kudryk[1], S.V. Novitskii[1], V.N. Sheremet[1], J. Li[3], and •S.A. Vitusevich[3] — [1]V. Lashkaryov Institute of Semiconductor Physics, NAS of Ukraine, Kiev, Ukraine — [2]State Enterprise Research Institute Orion, Kiev, Ukraine — [3]Peter Grünberg Institute, Forschungszentrum Jülich, Jülich, Germany

In the last decade, several authors reported on observation of anomalous behavior of contact resistance, Rc, in ohmic contacts to semiconductors with high dislocation density: it increased with temperature starting at room temperature. In particular, the authors of [1-3] observed the increasing temperature dependences of contact resistance in the In-n-GaP and In-n-GaN contacts. The experimentally obtained Rc(T) curves were in contradiction with the thermionic and thermal-field emission mechanisms at which Rc has to decrease with the temperature increase. In [1-3], the results obtained were explained by assuming that current flow in semiconductors with high dislocation density is limited by resistance of metal shunts associated with dislocations. At temperatures above the Debye one, the resistance of metals increases linearly with temperature; therefore, one would observe increasing Rc(T) curves. However, the experimental Rc(T) were not linear as a rule. Usually they demonstrated a decreasing part at low temperatures, then with the temperature increase the Rc value passed through a minimum and began to increase. Here we report on a new mechanism of contact resistance formation in ohmic contacts to semiconductors with high dislocation density. This mechanism takes into account current flow through the metal shunts associated with the grown-in dislocations as well as current flow limitation with the diffusion supply of electrons. An essential distinction from [1] is the assumption that current flows through the regions of electron accumulation rather than depletion. Being combined, the above considerations allow to explain the decreasing portion of Rc(T) curve at low temperatures and growing one at higher temperatures. This is true not only for ohmic contacts to n-GaP and n-GaN but for contacts to other semiconductors with sufficiently high dislocation density as well. Realization of the above mechanism does not exclude a possibility of Rc decrease with temperature. This is likely in structures with low optical phonon energy and may be illustrated by the example of In-n-GaAs [2] and Au-TiBx-AuGe-n-GaAs ohmic contacts. A comparison of the theory with both our experimental results and those obtained in [1-3] is performed. It is of particular importance that the presented concept can explain the experimentally observed contact ohmic behavior regardless of relation between the semiconductor bulk and contact resistances. The theory is proved for contacts formed to III-V semiconductor materials as well as silicon-based materials. A reasonable agreement between theory and experimental results is obtained. [1]T.V. Blank, Yu.A. Gol'dberg, O.V. Konstantinov, V.G. Nikitin, E.A. Posse. Techn. Phys. Lett. 30, 806 (2004). [2]T.V. Blank, Yu.A. Gol'dberg. Semiconductors 41, 1263 (2007). [3]V.N. Bessolov, T.V. Blank, Yu.A. Gol'dberg, O.V. Konstantinov, E.A. Posse. Semiconductors 42, 1315 (2008).

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