Early View publication on www.interscience.wiley.com
(issue and page numbers not yet assigned;
citable using Digital Object Identifier – **DOI**)

Phys. Status Solidi C, 1–4 (2010) / **DOI** 10.1002/pssc.200982404

physica status solidi c
www.pss-c.com
current topics in solid state physics

Comparison of metal Schottky contacts on n-Ge (100) at different annealing temperatures

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Received 22 June 2009, revised 16 October 2009, accepted 4 December 2009
Published online 26 January 2010

PACS 68.60.Dv, 73.30.+y, 81.15.Ef, 81.40.Ef

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Platinum (Pt), nickel (Ni), palladium (Pd) and cobalt (Co) Schottky barrier diodes were fabricated by vacuum resistive evaporation or electron beam deposition. We have studied the electrical characteristics of platinum, nickel, palladium and cobalt Schottky contacts on bulk grown (100) Sb-doped n-type germanium under various annealing conditions by current – voltage (*I-V*) measurements. The Schottky behaviour of the metal contacts with annealing temperatures is compared. Results obtained from the electrical properties of the Schottky contacts have revealed that Pt contacts are highly thermally stable over a wide range of temperature compared to Pd, Ni and Co contacts. Furthermore, Pt Schottky contacts are of highest quality, with low reverse currents of the order (10^{-6}- 10^{-5} A) and as-deposited ideality factor as low as 1.09, compared to Pd, Ni, and Co Schottky contacts.

1 Introduction Thin film reactions of metal on semiconductor have been of interest for the past 30 years for their applications in microelectronic devices [1]. In the manufacturing of semiconductor devices, metal contacts have always played a pivotal role, especially in MOSFET and CMOS devices. A good metal-semiconductor (MS) contact is essential for the successful operation of the electronic circuits and devices [2]. Contacts to very large scale integration (VLSI) circuits require MS contacts, which are thermally stable, have low resistivity and are compatible with the process technology. Schottky contacts play an important role in controlling the electrical performances of semiconductor devices [2]. The attempts to develop faster devices in modern microelectronics have increased the interest for alternative materials to silicon, compatible with the existing silicon-based technology [3]. Germanium (Ge) has been regarded as the replacement for silicon due to its high carrier mobility, low effective mass of holes [4] and relative compatibility with silicon processing. This has led to renewed interest in the complete understanding of metal-germanium interactions and electronic properties of radiation and process-induced defects in Ge.

The reactions of germanium with Pt[5 , 6 , 7], Ni [8,9,10,11,12], Pd [6,9,13,14,15] and Co [9,13,16,17] have also been investigated previously. Study of the solid state reaction between the metal films and germanium to determine the phase formation sequence [5,9,11,13,15,17], microstructure of material [9,10,12], growth kinetics[11,16] and electrical characteristics [9,10,12],were analyzed by x-ray diffraction, Rutherford backscattering spectroscopy, transmission electron microscopy, differential calorimetry and current-voltage (*I-V*) techniques respectively. Thanailakis *et al.* [8] established a relationship between as-deposited Pd/n-Ge (111) and Ni/n-Ge (111) Schottky barrier height values, the metal work functions and the density of surface states of germanium substrate. Yao *et al.* [10] studied the *I-V* characteristics of Pt/n-Ge (001) and Ni/n-Ge (001) after subjecting the Schottky contacts to rapid thermal anneal (RTA) in N_2 ambient in the temperature range 250-700 ^{o}C for 20 s. Han *et al.* [12] has reported the changes in the electrical properties of Ni germanide Schottky contacts on n-Ge (100) in the temperature range 300-500 ^{o}C.

The aim of this paper is to report the change in the electrical properties and give a comparative study of ther-