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High Temperature Oxidation of NiSi and $NiSi_2$ Films

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Silicides of transition metals are widely used in the modern silicon film industry because they have metallic conductivity, high melting temperatures, high corrosion resistance, and oxidizability. Schottky diodes, ohmic contacts to shallow-lying active elements, inter-element junctions, gate electrodes in metal–oxide–semiconductor structures constitute by no means a complete list of silicide applications in the very-large-scale integrated circuit (VLSI) technology. Highly conductive nickel silicides are very promising: their conductivity is an order of magnitude higher that of polisilicon and their properties remain stable to temperatures of about 1070 K

In this work the phase formation and thermal oxidation stability of NiSi and NiSi2 thin films on n-type Si (111) substrates have been investigated. The objects to study were thin-film layers of Ni (200nm) on monocrystalline Si substrate of orientation (111) doped with phosphorus. Thin-film system Ni/Si obtained by electron-beam deposition in vacuum 210^{-4} Pa. After deposition the samples were annealed in a furnace with oil-free vacuum pumping 1.3310^{-3} Pa in the temperature range 470 – 1270 K

For phase identification was performed in Electronograph EMR-100 using reflection diffraction method. The thermogravimetric analysis (TGA) was carried out in Derivatograph Q-1500D thermoanalytical instrument. The sample mass of 20mg was heated in a platinum crucible in static air atmosphere at a rate 5 K/min and a maximum temperature of 1270 K.

According to data TGA, high-temperature oxidation of the NiSi films and the associated increase in weight begins at about 250 degree higher than the oxidation of a silicon substrate. The oxidation of NiSi film starts at 930 K, which is approximately 100 K below the temperature at which $NISi_2$ films start oxidising. For both NiSi and $NISi_2$ oxidation types the SiO_2 thin protective layers have been formed. When temperature increases, the mass increment NiSi films becomes greater than that of $NiSi_2$ films. This difference is three times as great at 1270 K, which is due to the difference in their structure and stoichiometry. Due to high silicon content, nickel dicsilicide forms dense layers of silica on the surface during oxidation, which has substantial impact on the oxidation rate.