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Electrical Resistivity and Microstructures of the Pt Embedded Metal-n^+GaAs Ohmic Contact Systems.

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Metal-n^+GaAs Ohmic contact systems have been widely studied for the application of GaAs based electronic devices. For the fabrication of advanced MMICs(monolithic microwave integrated circuits), contact systems need several requirements: low resistance, thermal stability, sharp edge define, wide process windows and so on. Among various metal combinations, AuGeNi have been frequently used for about a quarter of a century because of its low resistance. This conventional system, however, have a drawback like balling-up morphology. In order to solve this, correlation between ohmic mechanism and microstructural changes at a metallurgical point of view was studied and reported by a few research groups.

In this paper, we have been developed Au/Pt/Ni/AuGe- and Au/Ni/Pt/AuGe-n^+GaAs for the application of MMIC devices. Minimum resistance is $9\text{x}10^{-7}\ \Omega\text{cm}^2$. The specific contact resistance remained nearly constant even after annealing for 3000 h at 300 ℃ under atmosphere ambient.

In both systems, X-ray diffraction results and Auger depth profiles show that the good ohmic contact is related to the formations of Au_7Ga_2, $PtAs_2$, and $Ni_{19}Ge_{12}$ compounds. AuGa compound enhances the creation of more Ga vacancies, allowing incorporation of Ge into Ga sites, and PtAs compound is piled up in the middle of AuGa layer to suppress effectively As outdiffusion from the GaAs substrate.

Microstructures investigated by cross-sectional TEM suppose that in above systems ohmic behavior was less sensitive to the position of grains formed at contact interface: the entire reaction layer was consisted of a single AuGa(beta phase) and PtAs grains were distributed in this single phase. Furthermore, Ge-contained grain were not found at contact interface but only AuGa single phase was directly contact to n^+GaAs layer.

Metals and GaAs undergo reaction only up to 1000 Å beneath GaAs surface and interfaces are very smooth in comparison to conventional Au/Ni/AuGe with balling-up and Au/Pt/AuGe with dendrite morphologies. Between the two investigated systems, only a slight difference in interface are observed. Faceted NiGe grains and dislocation networking in the vicinity are observed at above 486 h.