2-4 Ohmic Contacts to GaP Devices for Use at High Temperatures

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Ohmic contacts to GaP devices which will operate up to 500℃ were investigated from both metallurgical and electrical points of view. The contact must be metallurgically stable well above 500℃ and should have a low specific contact resistance. The results are also applicable to GaP light emitting diodes.

To determine potentially useful metals, the alloying points of GaP-Au, GaP-Al, GaP-Ag and GaP-Ni were measured. In each case, the metal was evaporated on a GaP wafer, the wafer was heated on a calibrated Mo strip-heater in an atmosphere of froming gas, and alloying was observed under a microscope. The measured alloying temperatures are given in Table 1. Although GaP-Ag and GaP-Ni have the higher alloying points, their wetting characteristics were found to be poor. A Ni on Ag on GaP structure was then tested and shown to overcome this problem. Therefore, systems of Ni on Ag with various dopants were principally investigated.

The Ag-base alloys and Ni were evaporated successively on a GaP (111) wafer doped with Te to a carrier concentration of 2×10^{-7} cm^{-3} and heated in an atmosphere of hydrogen at various temperatures for 3 minutes. The heatings together with I-V measurements were repeated at gradually increased temperatures. The results of Ni-Ge on GaP, Ni-Si on GaP, Ag-Sn on GaP, Ni on Ag-Ge on GaP, Ni-Ag on Ge on GaP, Ni on Ag-Te on GaP and Ni on Ag-Ge on GaP are shown in Fig. 1. The Ag-Ge alloy gave an ohmic contact but its specific contact resistance was of the order of 10^{-2} Ω cm^2. The specific contact resistances of Ag-Te and Ag-Sb-Te were around 10^{-3} Ω cm^2, which is exceptionally low for GaP having a carrier concentration of 2×10^{17} cm^{-3}. In particular, the Ag:Sb:Te = 100:10:1 (weight ratio) system which was alloyed at 700℃ showed a specific contact resistance value of 4×10^{-4} Ω cm^2.

Finally, the dependence of the contact resistance upon ambient temperature and the I-V characteristic at higher current density will be discussed.

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Table 1

Alloying Temperatures of GaP-Metal Systems

System	Alloying Temperature
GaP-Au	520℃ ± 20℃
GaP-Aℓ	635℃ ± 20℃
GaP-Ag	690℃ ± 20℃
GaP-Ni	760℃ ± 20℃

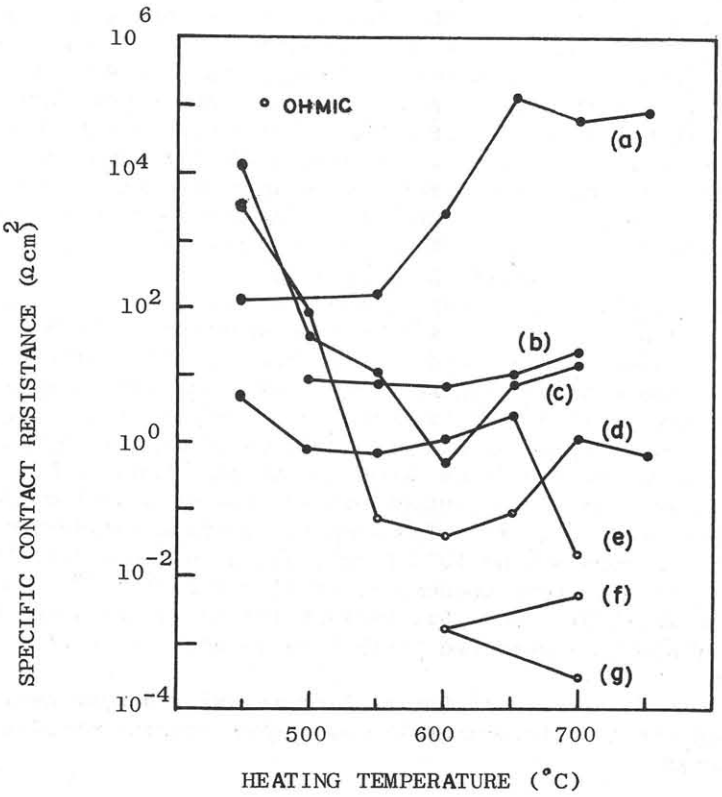

Figure 1. Specific contact resistance as a function of heating temperature. (a) Ni-Ge, (b) Ni-Si, (c) Ag-Sn, (d) Ni on Ag-Ge, (e) Ni-Ag on Ge, (f) Ni on Ag-Te, and (g)Ni on Ag-Te-Sb. The sample was heated for 3 min at each temperature.