INTERDIFFUSION OF THE p-InP WITH Au–Zn, Ti/Au, Pd/Au, Ti/Pd/Au AT INTERFACE AND THEIR ELECTRICAL PROPERTIES

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Abstract

In this report, the interdiffusion between the p-InP with Au–Zn, Ti/Au, Pd/Au and Ti/Pd/Au at interface have been investigated by Auger electron spectroscopy and electron spectroscopy for chemical analysis. The surface morphology for the heat treatment are observed with scanning electron microscopy.

It is found that the indiffusion of Au is easier than that of Pd and Ti and the outdiffusion of In is easier than that of P. The combination state of In and Au is formed during the heat treatment of p-InP/Au–Zn. The effects of the alloying temperature and time on the specific contacts resistance of p-InP/Au–Zn system are studied. The low specific contact resistance, \( \rho_e = 2.4 - 2.7 \times 10^{-4} \Omega \cdot \text{cm}^2 \), is obtained when alloying at 450°C for 2 min or at 550°C for 30 min.

These results indicate that the specific contact resistance strongly depend on the "interdiffusion degree". The Zn in Au–Zn alloy distributes onto the metal surface layer of p-InP/Au–Zn system during evaporation process and heat treatment. It may be one of the reasons for the higher specific contacts resistance.

I. Introduction

InP is the important material for optoelectronic devices. The device which used InP as substrate has characteristics such as \( \phi_{BB} > \phi_{Be} \) and \( \rho_m < \rho_{xr} \). Investigation for the interdiffusion between p-InP and contact metal and their electrical characteristics is important for improving parameters of the devices and their reliability.

Au/Be\(^{[3-4]}\), Ti/Au–Zn\(^{[5]}\), Mg/Au\(^{[6]}\), InZnAu\(^{[2]}\), Au/Zn/Au\(^{[7]}\), Au/Zn and Ti/Pd/Au\(^{[1]}\) are used as p-electrode contact metal. In this report, the interdiffusion between p-InP and Au–Zn, TiPdAu and surface photograph after heat–treatment have been investigated by AES, ESCA and SEM. The electrical characteristics have been measured by the four-point probe method.

II. Experimental Procedure

Zn doped single-crystal InP wafers were used as the starting material with carrier concentration \( n = 2 - 3 \times 10^{18} \text{ cm}^{-3} \). The slice of InP was chemically polished. Small pieces were placed into the sputter equipment with three targets. The samples were prepared by the sputtering the Ti to 500Å, Pd 3000Å and Au 3000Å or evaporating the Au–Zn to 300Å.

The samples were heat–treated at 450°C for 5 min in pure nitrogen atmosphere. For as–deposited sample and after heat–treatment at 450°C for 5 min the depth–composition profile were measured by AES. The surface photograph was observed by SEM. The contact resistance at different alloy conditions was measured by means of the four–point probe method.
III. Results

1. Interdiffusion of the p-InP and Au–Zn, Ti/Au, Pd/Au and TiPdAu

Depth–composition profiles of the p-InP and Au–Zn, Pd/Au, Ti/Au and TiPdAu for the as–deposited and after heat–treatment samples are shown in Fig. 1 to Fig. 4. It is found that

(1) Once the heat–treatment has proceeded, the distribution curve of the same system differs significantly from the as–deposited. The indiffusion of Au and outdiffusion of In and P will have occurred.

(2) The degree of interdiffusion between the contact metal and p–InP depends upon the species of the contact metal. The indiffusion of Au is easier than that of Pd and Ti, the outdiffusion of In is easier than that of P, the Ti or Pd layer as a diffusion barrier plays an important role.