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A1-4 Alloying behavior of Au and Au-Zn on GaP

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Ohmic contact to GaP has been investigated by a few workers[1-3]. Au-Zn thin film is popularly used with the ohmic contact material of P-GaP, but good-reliable low resistance to this material is difficult to achieve reproducibly because of a lot of uncertainty as to the alloying behavior of Au and Zn atoms. The backscattering and channeling techniques of MeV He^+ ions have been successfully used for many workers to investigate the thin films on crystalline solids[4], and these techniques are useful for determining the composition of thin films and the depth distribution of atoms migrated into a crystal during the annealing processing. To use of the channeling technique is extermely important for determining the lattice location of impurities in single crystals. In this work, the same techniques have been used to investigate the profile and lattice location of Au atoms migrating from the Au and Au-3wt%Zn films on GaP after various alloying temperatures and times.

Samples were N-GaP single crystal grown by Liquid Encapusulated Czochralski method and the orientation and the carrier concentration were $\langle 111 \rangle$ and 5×10^{17}--$2\times10^{18}cm^{-3}$ respectively. The Au and Au-3wt%Zn films were deposited on a heated substrate at about 200°C. The alloying were made in an open tube furnace with the ambient of N_2 and H_2. Backscattering and channeling measurements were carried out using 1.8MeV He^+ ions on the Van de Graaff of the Ion Implantation Group in Osaka.

The random spectra of He^+ ions backscattered from Au-GaP before and after alloying at 525°C for 7min. are shown in Fig.1. The random spectrum before alloying has a peak at channel 240 corresponding to He^+ ions backscattered from Au atoms on the surface of Au-GaP, and has two steps in this spectrum at channel 210 and 150. One of two steps corresponds to He^+ ions backscattered from Ga atoms on GaP surface, and the other from P atoms. This indicates that GaP is the compound semiconductor consisting of the different mass numbers between Ga and P atoms. Because of the energy slowing down of particles traversing the Au layer, both Ga and P edges of the random spectrum for the GaP are shifted to lower channel numbers than those of the uncoated GaP. Both Ga and P edges of the random spectrum for the GaP after the alloying at 525°C for 7min. are shifted to higher channel numbers and correspond to the edges for the uncoated GaP. The profile of the Au migrating into the sample can be seen a broad tail extending to lower channel numbers from the peak at 240. The aligned spectra along various axes and random spectrum for Au-GaP after alloying at 525°C and 600°C for 7min. are shown in Fig.2. In the portion of spectra of He^+ ions backscattered from the Au atoms at 525°C, there is extermely different between the aligned along the $\langle 111 \rangle$ and the random, but the aligned along the $\langle 110 \rangle$ coincides with the random. This indicates that all of the Au atoms migrating into GaP are not on substitutional sites, and approxmately a half of Au atoms occupies tetrahedral intersti-

tial sites after alloying at 525°C. However, after alloying at 600°C aligned spectra both along the ⟨111⟩ and ⟨110⟩ coincide with the random. This indicates that all of Au atoms are neither on substitutional nor tetrahedral interstitial sites.

Aligned spectra along the various axes and the random spectrum for Au-3wt%Zn GaP after alloying at 525°C for 7min. are shown in Fig.3. In the alogned along the ⟨111⟩ and the random spectrum, but the aligned spectrum along the ⟨110⟩ coincides with the random. This indicates that all of Au atoms are not on substitutional sites and a small part of Au atoms occupies tetrahedral interstitial sites.

The profile of Au atoms migrating into GaP for Au-GaP and Au-3wt%Zn-GaP at various alloying temperatures are shown in Fig.4. For Au-GaP, the concentration of Au atoms close to the crystal surface after alloying at 600°C is less than that at 525°C. The profile of Au atoms migrating into GaP at 600°C has a broader exponential tail as compared with that at 525°C. In contrast with Au-GaP, the profile of Au atoms for Au-3wt%Zn-GaP sample after alloying at 525°C has a broad tail as same as that of Au-GaP after alloying at 600°C.

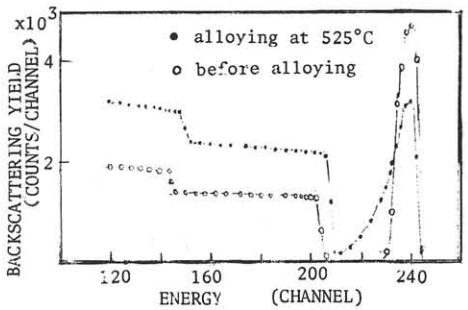

Fig.1 Random spectra for 1.8MeV He^+ ions backscattered from an Au-GaP as deposited sample and after a 525°C 7min. alloying.

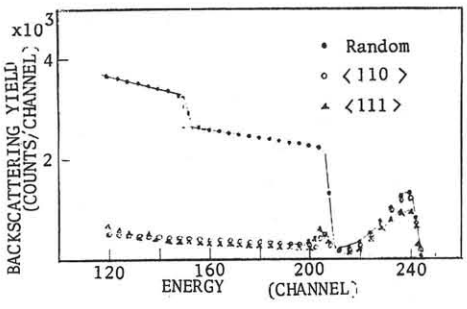

Fig. 3 Random, ⟨111⟩ and ⟨110⟩ aligned spectra for 1.8 MeV He^+ ions backscattered from Au-Zn GaP sample after 525°C 7min. alloying.

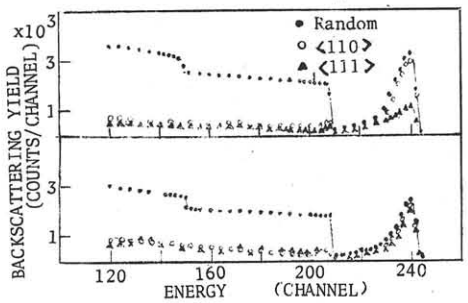

Fig.2 Random ⟨111⟩ and ⟨110⟩ aligned spectra for 1.8MeV He^+ ions backscattered from Au-GaP sample after 525°C 7min. (top spectrum) and 600°C 7min. alloying (bottom spectrum)

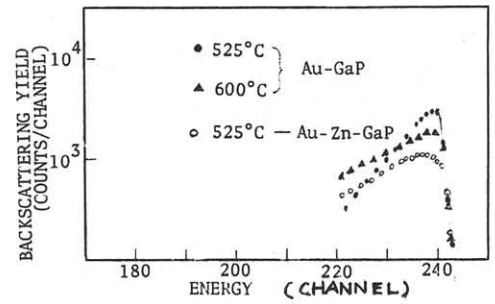

Fig. 4 Energy spectra of 1.8 MeV He^+ ions backscattered from Au for the sample covered by Au and Au-Zn on GaP and subsequently alloyed at 525°C and 600°C for 7min.

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