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MOVPE Growth of Beryllium Doped Inp Using Bismethylcyclopentadienyl-Beryllium

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InP related materials are widely used III - V semiconductors for the fabrication of many optoelectronic devices. Most of these applications requires abrupt doping profiles and high quality hetrointerfaces in InP/InGaAsP. Zinc (Zn) has been the most common p-type dopant for the InP layer grown by metalorganic vapor phase epitaxy (MOVPE) [1]. There has been, however, a problem on its doping controllability due to the large diffusion coefficient. In the MBE growth of GaAs, beryllium (Be) has been experimentally found as a very suitable candidate having a smaller diffusion coefficients. However, there is no report on doping of InP with beryllium in MOVPE. In this paper, we have for the first time applied Be as a p-type dopant for the MOVPE InP layer , and discuss some properties including electrical characteristics of Be-doped InP using bismethylcyclopentadienyl-beryllium.

Be-doped InP layers were grown using a low pressure vertical MOVPE reactor. Fe-doped (100) oriented InP substrates were used. The source materials were trimethylindium (TMI) and phosphine (PH_3;100%). Liquid bismethylcyclopentadienyl-beryllium ($(MeCp)_2Be$) at 20℃ was used as Be source. The growth temperature was 640℃. Typical growth rate and V/III ratio were 3.5μm/hour and 100, respectively. All samples showed good surface morphology.

Figure 1 shows the carrier concentration of Be-doped InP, which are measured by Van der Pauw Hall method, as a function of H_2 carrier gas flow rate through $(MeCp)_2Be$. The carrier concentration increases with increasing H_2 carrier gas flow rate and saturates at 4×10^{18} cm^{-3}. Figure 2 shows the temperature dependence of the carrier concentration for Be-doped InP. The temperature range is from 77 to 300K. The carrier concentration of the sample increases with increasing temperature. We can calculate temperature dependence of the free carrier concentration of the samples using electrical neutrality condition, when energy level (Ea) and concentration (Na) of acceptor (beryllium) are given. The solid line, which is calculated from the values (Ea=21 meV, Na=1.8×10^{18} cm^{-3}), agrees well with the experimental values as shown in Fig.2. This value of Ea is smaller than that of Zn acceptor (34 meV) in InP.

This study indicates that Be is the most promising p-type dopant alternative to Zn for the MOVPE InP growth.

[1] A.W.Nelson and L.D.Westbrook ; J. Appl. Phys. 55 (1984) 3103 .

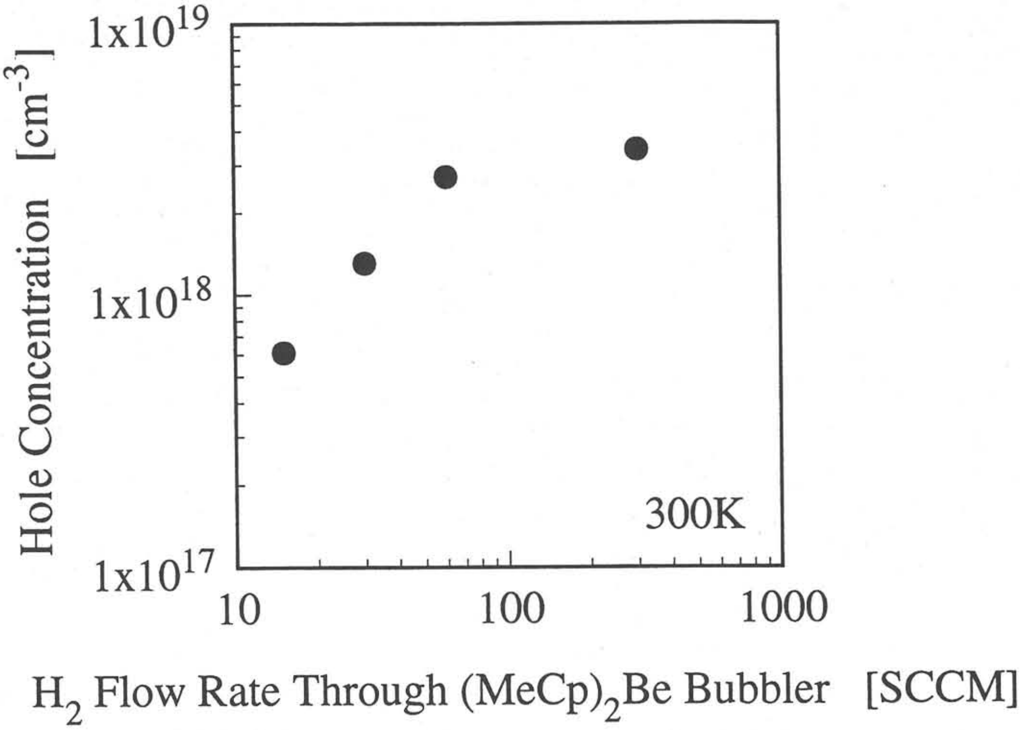

Figure 1 Carrier concentration of Be-doped InP, which are measured by Van der Pauw Hall method, as a function of H2 carrier gas flow rate through (MeCp)2Be.

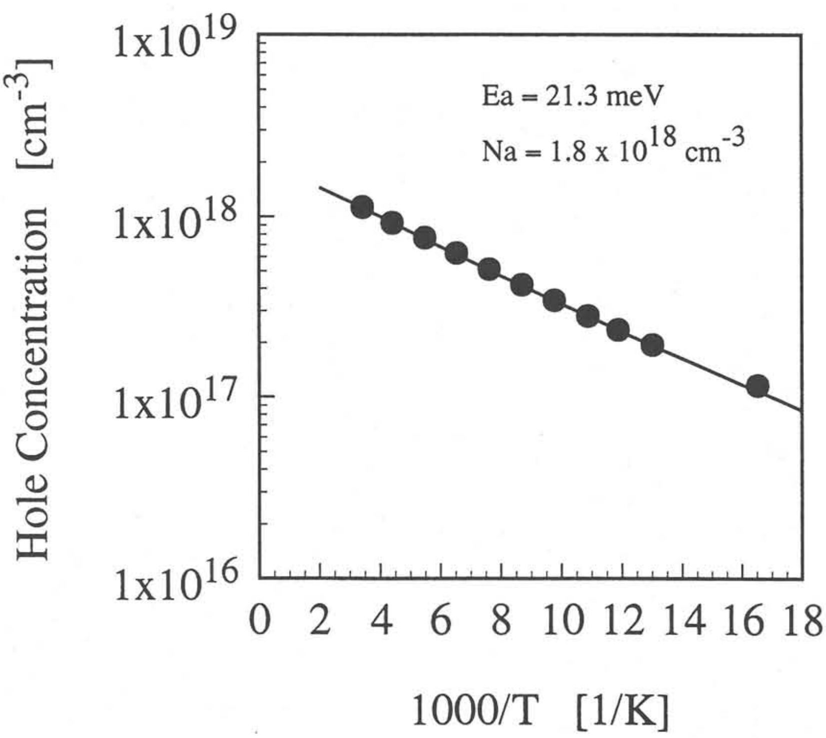

Figure 2 Temperature dependence of the free carrier concentrations measured by Van der Pauw Hall method. The solid lines are the free carrier concentrations calculated from the values (Ea=21 meV, Na=1.8 x 10^{18} cm^{-3}).