

Analysis of Cs Layer on InGaN by Temperature-Programmed Desorption Method

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The III-V semiconductor with a few monolayers of alkali metals, such as Cs, forms a negative electron affinity (NEA) surface, for which the vacuum level lies below the conduction band minimum of the base semiconductor. The NEA photocathodes have various advantages, such as low emittance and high spin polarization.¹ NEA-InGaN, which is sensitive to blue light, has been studied as a material for the next-generation robust photocathode.² However, the actual adsorption structures of alkali metals forming the NEA surface are not understood.

In this study, the adsorption states of Cs on the p-InGaN(0001) forming the NEA surface were investigated by the temperature-programmed desorption (TPD) method using a quadrupole mass spectrometer (QMS). The photocurrent emitted by illuminating a 406-nm laser diode (LD) was monitored through the NEA activation and the following TPD measurement.

The Cs was deposited on the InGaN surface under room temperature (RT). Then, the InGaN sample was heated to 700 °C with the programmed rate of 10°C/min for the TPD measurement. As shown in Fig. 1, both the Cs desorption and the quantum efficiency (QE) had several peaks. This suggested that the adsorbed Cs had several states. The QE showed the maximum peak at around 200 °C. It is considered that the Cs state changed to the suitable state for the emission by heating the sample.

The sample surface was cleaned and then activated again. Prior to the TPD measurement, the sample was kept under the vacuum condition for 45 hours in the order of 10⁻⁸ Pa. As shown in Fig. 2, the peak of the Cs desorption and the QE recovery at around 200°C seen in Fig. 1 disappeared. It is considered that the thermal desorption of Cs occurred, leaving for a long time even at RT. Consequently, the Cs, which greatly contributed to photoelectron emission, was weakly bound to the InGaN surface and easily desorbed at the low temperature.

¹ T. Nishitani, M. Tabuchi, H. Amano, T. Maekawa, M. Kuwahara, and T. Meguro, *J. Vac. Sci. Technol. B* **32** (2014) 06F901.

² D. Sato, T. Nishitani, Y. Honda, and H. Amano, *Jpn. J. Phys.* **55** (2016) 05FH05.

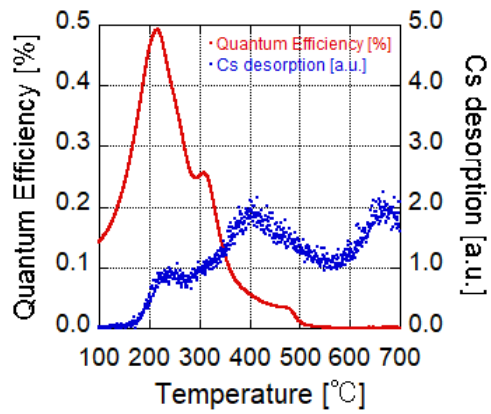


Figure 1: The change of the quantum efficiency and the Cs desorption: The quantum efficiency and the Cs desorption have several peaks.

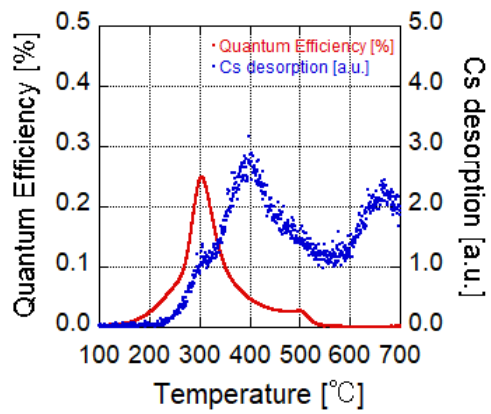


Figure 2: The change of the quantum efficiency and the Cs desorption 45 hours after NEA activation: The peak of the Cs desorption and the quantum efficiency at the low temperature disappeared.