Healing Mechanism of Interfacial Voids in GaAs Wafer Bonding

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Bonding of III-V semiconductors has been used to fabricate optoelectronic devices. Interfacial voids, however, are inevitable since atomically smooth wafers are not available during the bonding. In this study, artificial voids were introduced at bonding interfaces to study how processing parameters affected the healing mechanism of interfacial voids in GaAs wafer bonding. After bonding, three kinds of crystallites were formed at the bonded interface: cylinder-shaped, diamond-shaped and dendritic geometries. It was found that the geometry and growth rate of these crystallites are controlled by the nucleation of new surface layers on the bonded planes and the total driving force. When there was no twin boundary at the bonding interface, the nucleation of a new layer on the bonded planes could be described by a pill-box model. Most of the crystallites were in the form of cylinders, as shown in Fig.1. On the other hand, when there was a (100) twin boundary at the interface, the twin-plane reentrant corners lowered the formation energy for the partial pill-box island. The growth rate of crystallites was higher than that of cylinder. When the void depth h was $\geq$ 200 nm, the driving force was small. Most of the crystallites were diamond-shaped (Fig.2). However, when the void depth was small (h $\leq$ 70 nm), the driving force was larger. Most of the crystallites were in dendritic geometries, as shown in Fig.3.

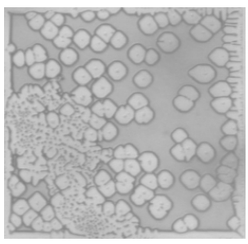

Fig. 1 IR transmission optical micrograph of 70 nm deep artificial voids in (001) GaAs normal boundary bonded at 900 °C for 12 h.

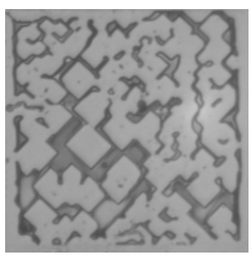

Fig.2 IR transmission optical micrograph of 200 nm deep artificial voids in (001) GaAs normal boundary bonded at 900 °C for 12 h.

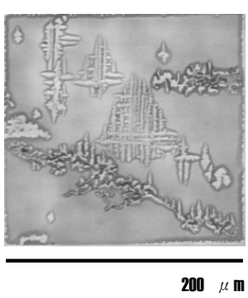

Fig. 3 IR transmission optical micrograph of 70 nm deep artificial voids in (001) GaAs twin boundary bonded at 900 °C for 2 h.