THE ROLE OF GLASS-FRIT BONDING IN ACHIEVING CRACK-FREE GaN-HEMT TRANSFER TO SILICON CARRIER FOR DIAMOND GROWTH

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Background: To address self-heating in high-power GaN-based high electron mobility transistors (HEMTs), diamond substrates (>2000W/mK thermal conductivity) significantly improve heat dissipation and efficiency. This approach comprises transfer of GaN HEMT epistructure onto silicon carrier wafer followed by CVD diamond deposition. Typically, fusion bonding process is employed to transfer GaN HEMT epistructures, which requires ultra-low surface roughness and wafer bow [1]. This study focuses on glass frit (GF) based temporary bonding, which provides greater flexibility in terms of roughness and wafer bow for transferring GaN HEMT epilayers onto the carrier wafer.

Methods: For GF bonding, ammonia-assisted MBE grown GaN HEMT on Si (RMS >3nm) was used. Glass paste was screen-printed and annealed at high temperature in N_2 ambient on both Si-carrier and GaN/HEMT, followed by bonding under constant pressure. After GF bonding, substrate was removed using mechanical grinding and ICP-RIE etching with SF_6 gas. Fig. 1 (a) illustrates the schematics of GF bonding method.

Results: XRD in Fig. 1(b) indicates removal of growth substrate, showing the absence of Si (111) peak and appearance of GF hump, after transferring to carrier wafer. Optical microscopy showed crack-free GaN epilayers on Si-carrier wafer. Moreover, GaN epilayers are only slightly tensile strained after the transfer process as observed by XRD and Raman peaks shift as illustrated in Fig. 1 (b) and Fig. 1(c).

Conclusion: GF-based temporary bonding provides a cost-effective, practical and effective way of transferring GaN-HEMTs onto Si-carriers without stringent surface roughness and bonding conditions as well as specialized handling equipment.