Abstract #1904, 224th ECS Meeting, © 2013 The Electrochemical Society

Comparison of SiC epitaxial growth from dichlorosilane and tetrafluorosilane precursors

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As a novel Si-precursor, tetrafluorosilane (SiF_4/TFS) exhibits unique properties to be used in chemical vapor deposition (CVD) homoepitaxial growth of SiC films. A comprehensive study of epigrowth using TFS will be presented and compared with growth using a chlorinated Si-precursor, dichlorosilane ($SiCl_2H_2$/DCS). In growth using TFS precursor, a major breakthrough in eliminating Si droplet formation and suppressing parasitic deposition (reduced about 80% compared to the epigrowth using silane or DCS) in the CVD process is observed due to its less reactive nature compared to silane and DCS. This is of great importance to increasing growth rate, reducing particulate deposition in the epilayer, and increasing the lift-time of the expensive reactor parts, thus reducing the fabrication cost of SiC high power devices.

In-situ surface preparation (or etching) in H_2 environment, which is an important step prior to the initiation of SiC epitaxial growth, is investigated in four conditions: (1) pure H_2, (2) $H_2 + C_3H_8$, (3) H_2 + DCS, and (4) H_2 + TFS. The results indicate that TFS is a strong SiC etchant in H_2 environment. TFS selectively reacts with Si on the SiC surface enhancing H_2 etching by faster Si removal from the surface in the form of SiF_2 gas. However, DCS was found to be an ineffective etchant, depositing significant amounts of Si on the surface of the SiC substrate. TFS is proposed to be an alternative choice for in-situ etching of SiC substrate prior to epigrowth compared to using HCl. The influence of in-situ surface preparation on defects in the subsequent epilayers will be discussed.

Epitaxial growth on various off-axis SiC substrates (8°, 4° off-cut and on-axis) is studied using TFS and DCS precursors. The epigrowth using DCS is Si-supply dependent, similar as the growth from silane precursor. However, the growth using TFS is found to be C-supply dependent. A comprehensive research regarding the influence of C/Si ratio on growth rate, doping control, polytype incorporation, and surface morphology will be presented. The defect evolution is studied by mapping the defects on the substrate and tracking their changes during the growth.

Acknowledgements: This work was supported by the ONR, Grant no. N000141010530. The authors gratefully acknowledge the program manager Dr. H. Scott Coombe for his support of this research.