3C-SiC on Si Hetero-epitaxial Growth for Electronic and Biomedical Applications

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Abstract

A simplified 3C-SiC growth process on 50 and 100 mm Si <100-4°> substrates has been developed in a low-pressure horizontal hot-wall chemical vapor deposition (CVD) reactor. The growth process consists of a single thermal ramp with the carbon precursor alone to the growth temperature followed by the 3C-SiC growth. In earlier work, the hetero-epitaxial growth of single crystal 3C-SiC on silicon (100) substrates (up to 50 mm wafer sample size) via CVD has been realized [1-4]. Several chemistry systems were employed with the goal to improve the 3C-SiC epitaxial layer quality and increase deposition rates: (1) The standard H_2-C_3H_8-SiH_4 precursor chemistry (growth rates up to 30 μm/h) [1], and (2) the H_2-C_3H_8-SiH_4-HCl precursor chemistry (growth rates up to 38 μm/h) [2-3]. The latter growth processes included the carbonization of the silicon surface followed by a slow growth thermal ramp including the silicon precursor. The former process was then modified to include a controlled variation of the Si/C ratio during the second thermal ramp after carbonization with the aim to improve the epitaxial film quality via reduced defect density. However; although improvements were obtained, it was concluded that the epitaxial film quality was still comparable to films obtained in the original process. Therefore, the modifications implemented added unwanted complexity and cost to the deposition process. As a result, focus was shifted into developing a simplified 3C-SiC growth process with the goal to make it more reproducible, easier to control and more cost effective without compromising epitaxial film quality.

Presently, our CVD gas chemistry has being adjusted to include the H_2-C_2H_4-SiH_4 precursor chemistry and our CVD reactor has been scaled up to accommodate 100 mm substrates. This paper reports on the progress made to date in the development of a simplified single crystal 3C-SiC growth process using the H_2-C_2H_4-SiH_4 precursor gas system on 50 mm and 100 mm silicon substrates. The 3C-SiC epitaxial layers were characterized via optical microscopy, secondary electron microscopy (SEM), atomic force microscopy (AFM), X-ray diffraction (XRD), and secondary ion mass spectrometry (SIMS). Applications of 3C-SiC for biomedical devices will also be presented as 3C-SiC has proven to be an ideal ‘smart material’ for this important application.

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