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Growth of SiC Oxidation Protective Coating Layers on Graphite Substrates Using Single Source Precursors

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Graphite with its advantages of high thermal conductivity, low thermal expansion coefficient, and low elasticity, has been widely used as a structural material for high temperature. However, graphite can easily react with oxygen at even low temperature as 400 ℃, resulting in CO_2 formation. In order to apply the graphite to high temperature structural material, therefore, it is necessary to improve its oxidation resistive property. Silicon Carbide (SiC) is a semiconductor material for high-temperature, radiation-resistant, and high power/high frequency electronic devices due to its excellent properties. Conventional chemical vapor deposited SiC films has also been widely used as a coating materials for structural applications because of its outstanding properties such as high thermal conductivity, high microhardness, good chemical resistant for oxidation. Therefore, SiC with similar thermal expansion coefficient as graphite is recently considered to be a good candidate material for protective coating operating at high temperature, corrosive, and high-wear environments. Due to large lattice mismatch (~50%), however, it was very difficult to grow thick SiC layer on graphite surface.

In this study, we have deposited thick SiC thin films on graphite substrates at temperature range of 700 - 850 ℃ using single molecular precursors by both thermal MOCVD and PEMOCVD methods for oxidation protection wear and tribological coating. Two organosilicon compounds such as diethylmethylsilane (DEMS), $(Et)_2SiH(CH_3)$, and hexamethyldisilane (HMDS), $(CH_3)_3Si\text{-}Si(CH_3)_3$, were utilized as single source precursors, and hydrogen and Ar were used as a bubbler and carrier gas. Polycrystalline cubic SiC protective layers in [110] direction were successfully grown on graphite substrates at temperature as low as 800 ℃ from HMDS by PEMOCVD. In the case of thermal MOCVD, on the other hand, only amorphous SiC layers were obtained with either HMDS or DEMS at 850 ℃. We compared the difference of crystal quality and physical properties of the SiC protective layers grown by thermal MOCVD and PEMOCVD methods and confirmed that PEMOCVD was highly effective process in improving the characteristics of the SiC layer properties compared to those grown by thermal MOCVD. The as-grown samples were characterized *in situ* with OES and RGA and *ex situ* with XRD, XPS, and SEM. The mechanical and oxidation-resistant properties have been checked. The optimum SiC film was obtained at 850 ℃ and RF power of 200 W. The maximum deposition rate and microhardness are 2 ㎛/h and 4,336 kg/mm^2 Hv, respectively. The hardness was strongly influenced with the stoichiometry of SiC protective layers.