Preparation of high temperature stable SiCBN films by spin-coating process of poly(borosilazane) and Other Polymer-derived Applications

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Abstract:

Polymer-deri1ved ceramics have been used for high temperature structural applications such as fibers, composites and coatings. However, we are recently more concerning on new applications in the fields of porous ceramics and nanostructural materials prepared from sacrificial templates and soft lithography techniques. At here, we simply introduce the major achievements including macroporous SiC, SiC nanotubes and various ceramic patterns. Moreover, it is expected that super-resistance ceramic may be desirable for development of high temperature micro-reactors and MEMS devices performable at harsh conditions. In this context, it came to our attention that the polymer-derived silicon-carbon-boron-nitrogen (SiCBN) ceramic showed extremely high thermal stability in air even at 1800 ^{o}C, with excellent mechanical strength. However, the synthesized polymeric precursors had some disadvantages with lack of processibility due to insolubility or pyrophoric property. In this work, the soluble and relatively stable poly(borosilazane) with ceramic yield 70-75% was newly synthesized by hydroboration between borazine (*h*-$B_3N_3H_6$) and 2,4,6-trimethyl-2,4,6-trivinylcyclotrisilazane. The amorphous SiCBN ceramic films were obtained by a single spin-coating process of poly(borosilazane) solutions on Si or SiO_2/Si substrates at different conditions, followed by pyrolysis at 900^{o}C. The films thickness in range 100~500 nm depended on concentration of the polymeric solutions. The morphology of prepared films showed smooth surface with roughness 0.21 - 0.44nm and dense structure with no crack as observed by SEM and AFM. By nanoidentation loading, surface hardness and elastic modulus of the SiCBN films leaded to 7.5 GPa and 65 GPa, respectively. The composition of SiCBN film was measured by AES analysis was a homogenous with ~ 2.4 Si/B ratio. Oxidation resistance of SiCBN films were measured by using isothermal TGA at 1000^{o}C in air for 8 hours with 0.06 % mass loss. In addition, the 900^{o}C-pyrolyzed SiCBN film under vacuum atmosphere is an insulator, exhibiting a room temperature sheet resistance of 10^{14} Ω/cm^2.

Keywords: SiCBN films, High thermal stability, Spin-coating

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