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Design and synthesis of Zr-containing multinary ceramics from hybrid polymers

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Polymer-derived method is superior in the fabrication of ultra-high-temperature ceramics with the designable composition and structure, low sintering temperature and easy densifying process. In this study, three kinds of hybrid precursors for ZrC/C, ZrC/SiC and ZrC/SiBNC multinary ceramics were synthesized via radical polymerization. ZrC/C ceramic precursor was synthesized using Cp2Zr ($CH_2CH=CH_2$) as monomer ZrC/SiC or ZrC/SiBNC precursor is obtained by further adding low molecular weight polycarbosilane (LPCS) or polyborosilazane (LPBSZ) for copolymerization. By controlling the preparation procedure, these hybrid polymers can dissolve in most organic solvent, which is essential to construct CMCs in complicated shapes and large sizes. After pyrolyzing at 1400°C, the synthesized precursors can convert into Zr-containing multinary ceramics, with ZrC nanoparticles finely dispersed in C, SiC or SiBNC matrix depending on the hybrid polymer. All of the three Zr-containing multinary ceramics can remain finely phase distribution at 1600°C, especially for ZrC/C and ZrC/SiC multinary ceramics, which can have a stabilized microstructure and little mass loss (less than 1.5 wt%) up to 2000°C in inert atmosphere. As for ZrC/SiBNC, the introduction of ZrC phase can restrict the decomposition of SiBNC matrix at 1800°C. Although the SiC and SiBNC components improve the oxidation resistance of ZrC, the oxidation weight increase of these multinary ceramics at about 500°C is still up to 5%.

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