第 10 回物質科学談話会

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Advanced Polymer-Derived (Ultra)-High-Temperature Resistant Ceramic Nanocomposites for Energy Conversion and Storage

Ralf Riedel

Technische Universität Darmstadt, Department of Materials and Geosciences, Dispersive Solids Group, Otto-Berndt-Str. 3, 64287 Darmstadt, Germany

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Despite significant efforts, which have been made in the last decade(s) in order to reduce the consumption of fossil resources and to move towards low or no emission energy techniques, combustion engines/machines will still play a major role in the next decades. This is partly due to the expected development of the world energy system until the year 2050. Thus, the total world energy consumption is expected to increase from 10 Gto (giga tons of oil equivalent) per year today to 22 Gto per year in 2050, of which fossil fuels (i.e., coal, oil and natural gas) will provide 70% and non-fossil sources (renewable and nuclear energy) 30%. Within this context and considering the limited availability of fossil resources, the development of strategies to increase the efficiency of combustion engines seems to be a logical consequence. As this correlates largely with the firing temperature, serious efforts in developing novel materials with ultrahigh-temperature (UHT) capability have been done recently.

In this presentation, polymer-derived ceramics capable to be operated at ultrahigh temperatures (i.e., T between 1200 and 1400 °C) as well as their potential for the fabrication of thermal barrier coatings (TBCs) and environmental barrier coatings (EBCs) will be presented. Beside details on their preparation, physical and thermomechanical properties thereof will be presented. Furthermore, the synthesis and the (U)HT behavior of Si Hf C X-based (X = O, N, B) ceramic nanocomposites will be discussed as novel candidate materials for top coats used in TBC applications in comparison to the zirconia-based state of the art coatings [1]. Information on the processing of the material classes to produce TBC/EBC systems will be also provided. Furthermore, novel candidate substrate materials based on the Mo-Si-B (molybdenum silicide boride) intermetallic system will be introduced, which exhibit improved (U)HT behavior with respect to the state-of-the-art Ni-base superalloys [2].

A second focus will address the application of polymer-derived ceramics for energy storage devices in form of novel anode materials for Li-ion batteries [3]. In particular, the electrochemical behavior of SiOC- and SiCN-based ceramics and composites are discussed.

Reference

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