Why not Using Ceramics – Trends from Ceramics Research

Within the Fraunhofer AdvanCer Alliance/DE, four institutes have pooled their capabilities to form a coordinated range of services aimed at using advanced ceramics in the creation of individual system solutions for industrial partners. Below, we present two examples from our successful project work showing the advantages of advanced ceramics in specific industrial applications

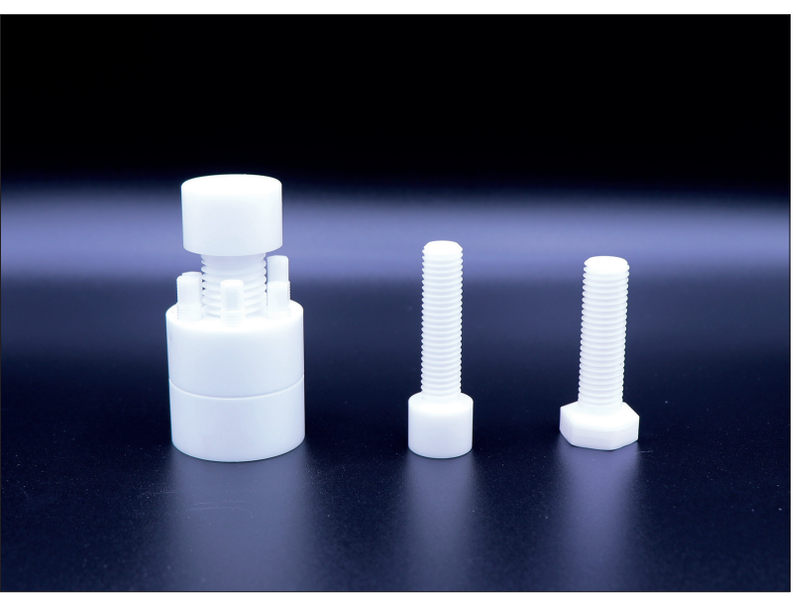

Fig. 1
ZrO_2 superbolt demonstrator and ZrO_2 screws (thread size M10) with standard metric thread geometry and with suitable-to-ceramic geometry (f. l. t. r.)

ZrO_2 threaded joints for use under high mechanical, thermal and corrosive loads

The demand for high thermodynamic efficiency of power plants, combined heat and power aggregates, pumps, etc. requires application temperatures in a range where steel is getting prone to creep under mechanical load as well as to corrosion. In consequence, threaded steel joints tend to get jammed after long time of operation in the high-temperature range; often the joints can hardly be removed any more without destruction. Even at lower temperatures (400 °C to approx. 600 °C), similar problems can arise due to failure of the used lubricant.

Thus, there is a substantial need for reliable, high-temperature and corrosion-resistant threaded joints which can be easily unbolted even after long use. BCE Special Ceramics GmbH/DE and the Fraunhofer Center for High Temperature Materials and Design HTL/DE have conducted a cooperation project to develop zirconium oxide based threaded joints for high-temperature applications up to 1200 °C, featuring high reliability, low fastening torque and easy loosening of the screws even after long period of application.

In the project, Fraunhofer HTL has developed a Mg-stabilized ZrO_2 ceramic material as well as an adapted sintering cycle. The successfully developed material shows good mechanical properties at much lower cost for the raw materials as compared to using commercially available batches. Additionally, a suitable-to-ceramic design for considerably reduced mechanical stresses in the screwed threads under load has been developed by means of finite element simulations.

Test screws and nuts with this thread design, manufactured at BCE GmbH by utilizing their high expertise in green body machining, showed 60 % increased torque strength compared to connections having standardized metric thread geometry. As a very special demonstrator a so-called “super-bolt” connector, providing high holding forces with relatively low torque needed for fixation, has been manufactured at BCE GmbH. The project was funded by the German Federal Ministry for Economic Affairs and Energy (ZIM project KF2242810AG3).

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