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Using pre-ceramic polymers in the joining of silicon carbide ceramics

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Organic-inorganic hybrid materials are becoming increasingly more useful in industry for combining polymers with ceramics. The resulting material offers a variety of characteristics of significant value to industry, including high mechanical strength and thermal resistivity. Using these hybrid materials, ceramics can adhere together effectively. Currently, an organic adhesive resin system is used to join silicon carbide (SiC) rods together. However, due to their toxicity there is a necessity to remove these from the application. Comparing the organic resins, as a joining agent, with pre-ceramic silicon based polymer resulted in a large difference in the quality of the joints produced from SiC rods. The rods mechanical strength and resistivity across the weld were compared as factors. A four-point flexural test and a four-point terminal resistivity test were used for this analysis. These polymer materials were analysed using Fourier-Transform infrared spectroscopy (FTIR) and differential scanning calorimetry (DSC) to determine the curing reactions occurring in both systems. Thermogravimetric analysis (TGA) was also performed to determine polymer retention at 800°C. Additionally, these welds were compared under an optical microscope to investigate the difference in the integrity of the welds produced. X-ray powder diffraction (XPD) was also used to analyse the polymer: ceramic conversion undergone at high temperatures for the silicon based polymer.The new silicon polymer rods showed much better strength and resistance values compared to the organic resin joined rods. Their integrity and retention at high temperatures also showed improvements over the current system used. It can be determined from this that they can be successfully used in this system as a replacement for the organic resin. This makes the materials much safer and much more effective as a joining adhesive for the SiC rods.

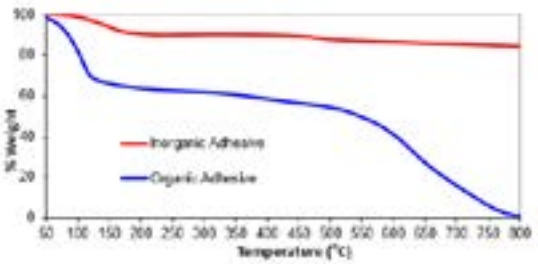

Figure 1: Thermogravimetric analysis graph showing the mass retention up to 800° C of the organic and inorganic adhesive

Recent Publicatiotns

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3. Key T S, Wilks G B, Parthasarathy T A, King D S, Apostolov Z D and Cinibulk M K (2018) Process modeling of the low-temperature evolution and yield of polycarbosilanes for ceramic matrix composites. Journal of the American Ceramic Society, 101(7):2809-2818.

4. Jeong D H, Septiadi A, Fitriani P and Yoon D H (2018) Joining of SiCf/SiC using polycarbosilane and polysilazane preceramic mixtures. Ceramics International, 44(9):10443-10450.

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Biography

Lewis J Print is pursuing his PhD in Polymer Chemistry at the University of Strathclyde. Under the supervision of Dr John J Liggat L. Print focuses on the development of methodologies to adhere silicon carbide ceramic using polymers for high temperature applications. This includes utilising a variety of analysis technique to characterise these polymers: including thermal analysis, thermal degradation and spectroscopy techniques. He also has interests in biodegradable polymers, the mechanical and physical properties of various polymers and novel applications of IR spectroscopy.

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