CERAMICS FOCUS AREA

Objective: Development of carbon fibre reinforced ultrahigh temperature ceramics

The surfaces of the ceramics made were analysed by TEM and SEM. The mechanisms for the corrosion process was described. The PhD thesis of the student was examined and the student has now. One paper was published. (P.S. Makurunje and I. Sigalas)

Objective: Pyrophyllite materials characterisation and development

The student has submitted his dissertation, which was passed. He is waiting to graduate. (W. Molomo, P. Rokebrand, R. Sule and I. Sigalas)

Objective: 3D printing of pyrophyllite by robocasting

The student had graduated. He is submitting a research paper from his work. (L. Janse van Rensburg, D.J. Whitefield and I. Sigalas)

Objective: Development and characterisation of $MgAl_2O_4$-ZrO_2 composite ceramic materials

Spinel powder as well as 3 wt% Y_2O_3-ZrO_2 powders were mixed at ratio of 0-30 wt% Y_2O_3-ZrO_2-$MgAl_2O_4$, making a new type of strengthened ceramic matrix composite. The resulting materials were analysed. The transverse rapture strength was measured. The dissertation was submitted in December 2020. (F. Marais, D.J. Whitefield and I. Sigalas)

Objective: Fabricating transparent spinel by Spark Plasma Sintering

Transparent spinel ceramics made with 1 wt% LiF doped spinel were made. The properties of the material were good, but the addition of LiF caused contamination in the SPS furnace, although it was possible to complete the work. (F. Marais, D.J. Whitefield, N. Ntholeng and I. Sigalas)

Objective: Refractory ceramics development

An in-depth survey of the field has been done and strategies for entering the field were developed. (N. Ntholeng and I. Sigalas)

Objective: Development of ceramics gel casting technology for titanium

The purpose of this project is to develop a gel-casting process suitable for titanium powder. In previous iterations of this project, it was found that the typical gels used to create ceramic powder slurries were not suitable for typical titanium powder used for additive manufacturing. Several potential reasons for the incompatibility were explored: ζ-potential of the suspension, surface charge differences between ceramic (anionic) and metallic (cationic) particles, and the influence of the powder particle size effect on the ability to form a stable slurry. Several different gel-binder formulations were evaluated, focusing on the influence of the above-mentioned factors on the different systems. Ultimately, a novel process was designed where the gelation procedure is initiated while the slurry is still being mixed. The increase in viscosity due to the onset of gelation results in the suspension of the metal particles, according to Stoke's Law. This work was presented at the RAPDASA 2019 conference, with the student graduating in March 2020 with his MEng. (J. Piek, D. Blaine and I. Sigalas)

A new MEng student started on this project in 2020, focusing on the further development and refinement of the gel-casting systems that have been developed for titanium. It should be noted that the MEng (Mech) programme at Stellenbosch University requires each student to complete a semester (6 months) of postgraduate coursework, delaying the onset of their research study. The student successfully completed all six required modules, and submitted his research proposal in May 2020. The study was approved and the student spent the rest of the year, mostly under COVID-19 lockdown at home, conducting an in-depth literature review, and designing his study and experiments. (W. Erasmus and D. Blaine)

Objective: Design and building of an environmentally controlled chamber for the drying step in gel-casting

An environmentally controlled chamber was designed and built to provide a controlled temperature and humidity environment for the drying step in gel-casting. Initial studies indicated that controlling the drying atmosphere is beneficial in preventing the formation of mud-crack defects in the gel-cast green parts. This apparatus will be used in further research on gel-casting. (Gail Wheeler (BEng final year) and D. Blaine)