Universität Bremen

Master Thesis: Influence of the Stress state on the strength of Brittle Materials

Summary

Ceramics with high strength and low weight are essential for efficient lightweight component design. Understanding their deformation and failure mechanisms is crucial for efficient light weight component design. However, their use in industrial applications is limited due to their behavioral changes in stressed conditions. Three-dimensional testing is needed to explain the entire deformational response, as brittle materials significantly influence compressive characteristics and failure mechanisms due to multiaxial stress conditions. As a result, the focus of this effort is on dimensioning a previously developed (in FG Ceramic Materials and Components) triaxial apparatus to conduct triaxial testing. For this tests, alumina-mullite ceramic composites were produced by freeze casting. Freeze casting was used to make alumina-mullite ceramic composites for these testing. The freeze casted samples were sintered at two different temperatures, 11000 C and 13000 C, and designated as batch 1 and batch 2, respectively. The initial technique of testing is to provide a confining pressure to the rubber, which causes transverse and radial stress to the ceramic specimen, and then apply an axial force. However, this approach did not work since the rubber sample pushed out the pressure ring, making it impossible to apply the axial force. A series of unplanned studies with extended evolution of results was carried out to overcome the problems and develop a new test procedure. The new testing technique involves loading the ceramic specimen and rubber with a single force and calculating the force acting on the ceramic and rubber independently. Water intrusion porosity tests were performed on both bathes of ceramic specimens, and it was discovered that batch 1 specimens had lower porosity than batch 2 specimens. The findings of the uniaxial compression testing revealed that batch 1 ceramic specimens showed higher compressive strength than batch 2. The compressive strength of both batches rose dramatically with confining pressure, according to triaxial results. In summary, producing a triaxial stress condition on the ceramic specimens in our work reduced fracture development by providing confining pressure.