DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering
PhD Defense

December 6, 2024 at 4:00pm
LeBow Engineering 240 – Hill Conference Room

New Approaches to Understanding Stress Concentration Sensitivity in Pharmaceutical Powder Compacts

Name: Joseph Wright
Advisor: Antonios Zavaliangos

Abstract

The compaction of powder to produce bulk shapes is an economical process that is used in the pharmaceutical, confectionary, and metal product industries. In this process, powder precursor materials are pressed together to form a compact or tablet. The material characteristics, press parameters, and post-processing all influence the characteristics of such products. In this work, powder compacts are examined for their sensitivity to a central hole defect, which was previously used for the brittle fracture index (BFI). Through the combination of finite element modeling (FEM) and experimental work, this work directly relates the applied stress ratio (ASR), a direct evolution of the BFI, to the internal microstructure of the powder compacts. We develop an "equivalent crack length" representative of the behavior of the compact, which is prone to fracture in many locations due to the powder particulate bonds that are distributed throughout the product. This equivalent crack is proposed as a single metric of length that can be related to the size of the powder particles, and the fracture resistance of compacts can be expressed as a function of the microstructure. This work examines the initial development and validation of the equivalent crack length, variations in the equivalent crack length for different tablet geometries and hole manufacturing methods, and confirmation of the basis of the technique through a finite element cohesive zone implementation. The development of such a metric holds incredible value for industries that manufacture powder compacts, as the selection of specific powder materials can be performed with the ultimate fracture performance in mind. Additionally, the specific geometry important to the test is identified and allows scientists to perform direct comparisons between materials and samples.

Zoom link: https://drexel.zoom.us/j/7928600178