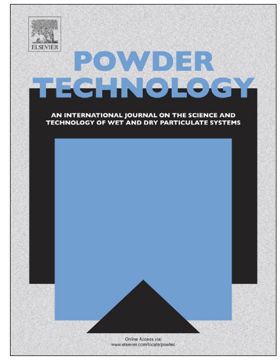

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XRCT characterization of mesoscopic structure in poured and tapped cohesive powders and prediction by DEM

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Abstract

Predicting structural and flow characteristics of cohesive powder systems is a technical challenge in many powder technology applications. The discrete element method (DEM) is a promising approach to model the mesoscale structure and flow behavior of cohesive granular systems. Advances in experimental techniques such as X-ray computed tomography (XRCT) have enabled characterization of powder systems with sub-micron resolution. Combined with standard bulk powder characterization methods, this technique allows for mesoscopic structural characteristics of cohesive powder systems to be compared directly with DEM simulation. In this study, DEM and XRCT are used to characterize the structural characteristics of two moderately cohesive roughly spherical 'model' powders – glass and stearic acid – under loosely poured and tapped consolidated conditions. The DEM simulations are based on a constitutive elasto-plastic model that makes use of the JKR theory to account for cohesive interparticle surface forces. Powder density and mesoscopic void structure obtained from DEM simulation are compared to characterization results obtained from XRCT image analysis. The results show that DEM can accurately predict the extent of tapping induced densification and mesostructure characteristics in cohesive powders, with superior agreement for stearic acid.

Keywords: Cohesive powders; Densification; XRCT; DEM;

1. Introduction

Predicting and characterizing mesostructural characteristics of fine (< 100 μm) cohesive powder systems under poured and consolidated conditions remains a challenging area of research relevant to industries that design and process powder products. The microstructural state of cohesive granular systems is relevant to development of strength with densification, formation of non-random (ordered) mixtures (that resist demixing) [1, 2] and other behavior [3-6].

One of the defining characteristics of fine cohesive powders is elevated porosity (lower density), due to local void regions created by open packing structures (particle chains) supported by cohesive forces within the