IFPRI

International Fine Particle Research Institute

Research Project Brief

Air-Induced Defect Formation During Powder Compaction

The International Fine Particle Research Institute (IFPRI) wishes to fund a research project in the area of modeling of structure evolution in aerated powders during high-speed die compaction.

A high-speed tableting process not only results in large deformation and concomitant strength development of the powder compact, but also can give rise to pore pressure buildup due to incomplete evacuation of the air in the densifying compact. If the compaction is sufficiently fast, the air pressure can be comparable to the strength of the compact and hence cause macroscopic defects in the solid structure.

The project should consider the effect of air flow / permeation on pore network and defect formation in powder compacts. It should build on prior IFPRI-sponsored efforts on compaction modeling (Zavaliangos, J. Pharm Sci. 106(8) 2088-2096) and pore-scale transport modeling (Cnudde, 2014 IFPRI review) and offer a new perspective that integrates the dynamics of a highly-compressible fluid and a porous deformable solid, hence expand our capability to predict air-induced tableting failures. With such framework, insights into the air-induced formation of heterogeneities, anisotropies, and defects in the powder compacts can be explored. Further, modeling-based process optimizations to avoid air entrainment and associated defect formations can be achieved.

Specific objectives of this project include:

- Develop a theoretical and/or numerical framework that dynamically couples the deforming powder bed with the associated air permeation during the powder compaction process. Construct local 3D constitutive relations based on such coupling.
- Explore the effects of relevant material properties, e.g. polydispersity, particle morphology, surface roughness, visco-elasticity, material mixture, etc.
- Allow for cross-validations against experimental results.