EXPERIMENTAL INVESTIGATION ON SHAPE SEGREGATION OF 3D PRINTED PARTICLES USING A FT4 FREEMAN RHEOMETER

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Abstract

This study examines how granular mixtures of differently shaped particles segregate in a Freeman (FT4) rheometer. The mixtures contained two sets of particles with varying shapes and relative sizes. While our main focus was on the effect of particle shape on segregation, we recognized that even slight differences in size could lead to segregation. We specifically investigated when particles of different shapes have the same effective size, exploring three cases: 1) the largest sphere within a cubic particle (inscribed sphere), 2) the smallest sphere enclosing a cubic particle (circumscribed sphere), and 3) a sphere and cube with equal volume. Our findings reveal that binary mixtures of cubical and spherical particles can significantly segregate radially in the bed. We propose that the primary mechanism for this radial segregation is percolation caused by radial centrifugal forces pushing the particles outward.

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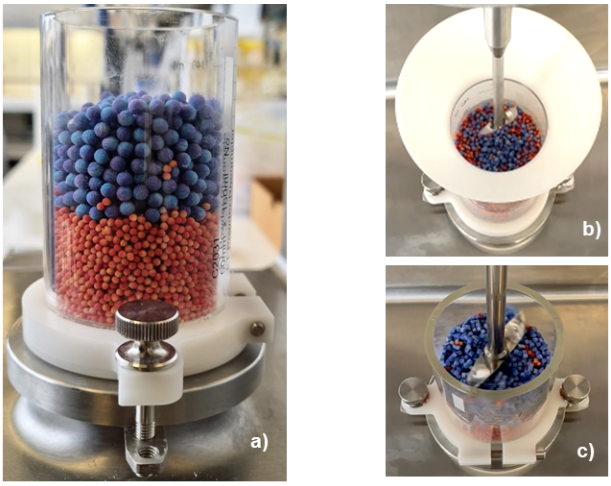


Figure 1 - Freeman rheometer apparatus used for the experiments a) Cylinder – 50mm in diameter and 90mm in height b) 23.5mm diameter (smaller) blade c) 48mm diameter (larger) blade. Note: Please be aware that the cylinder diameter remains consistent throughout all experiments.

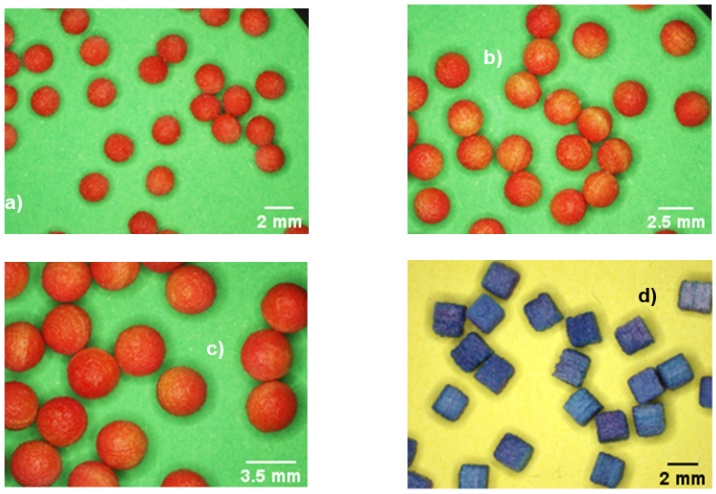
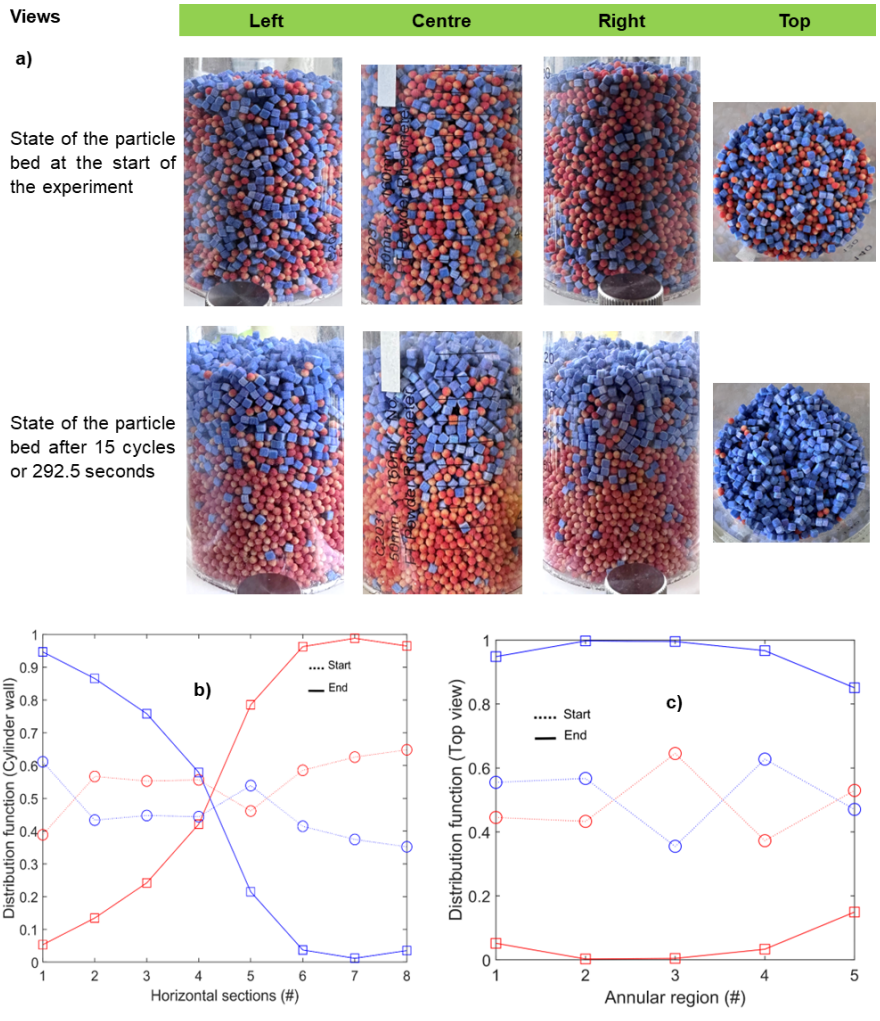
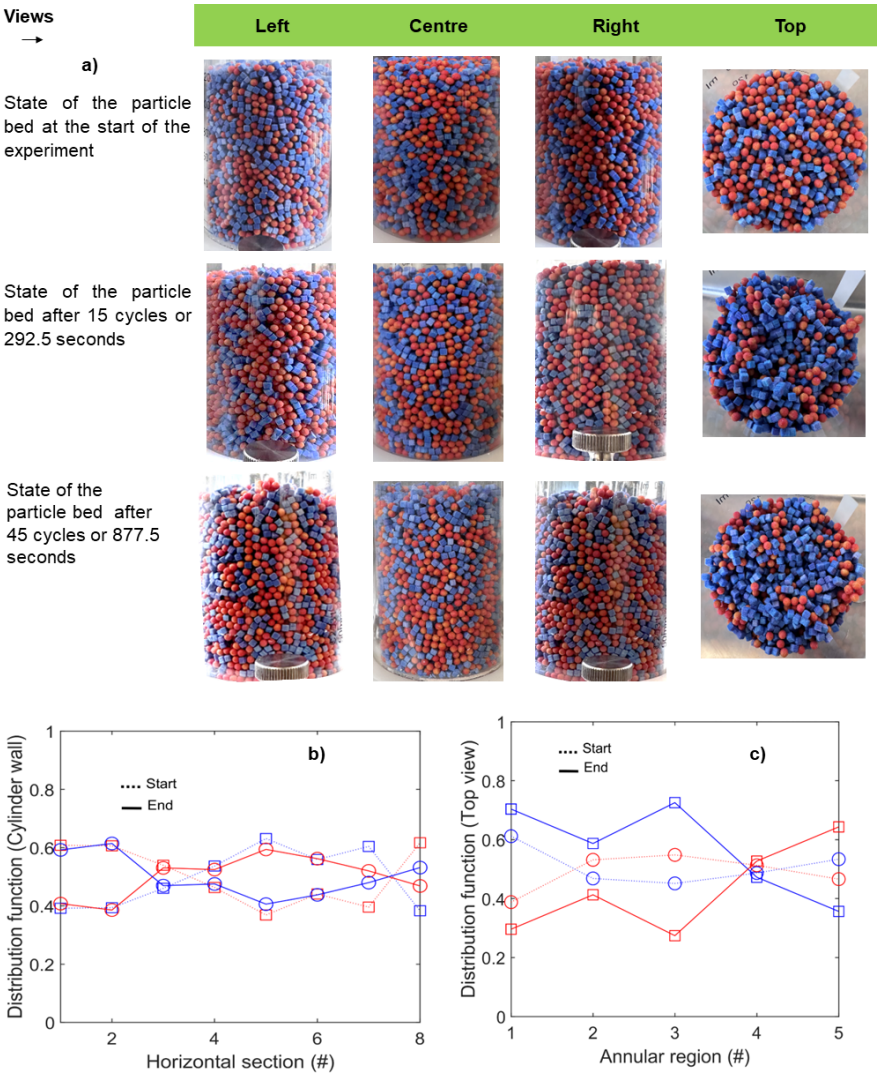
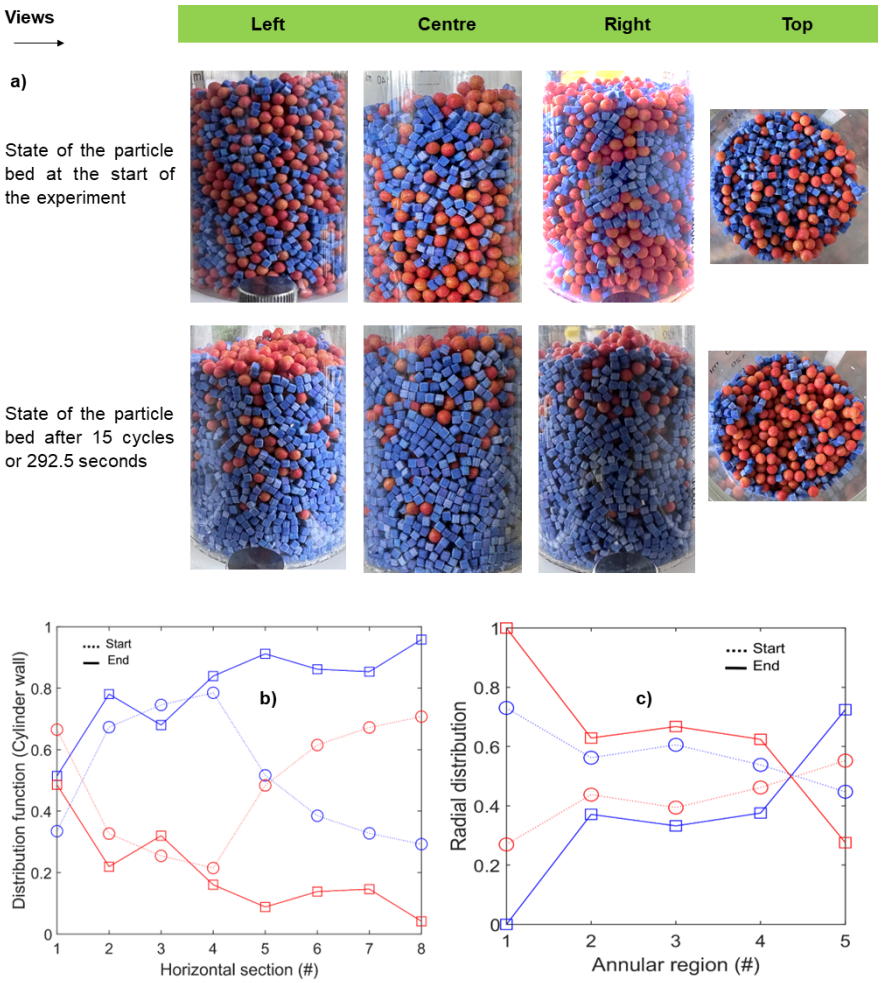
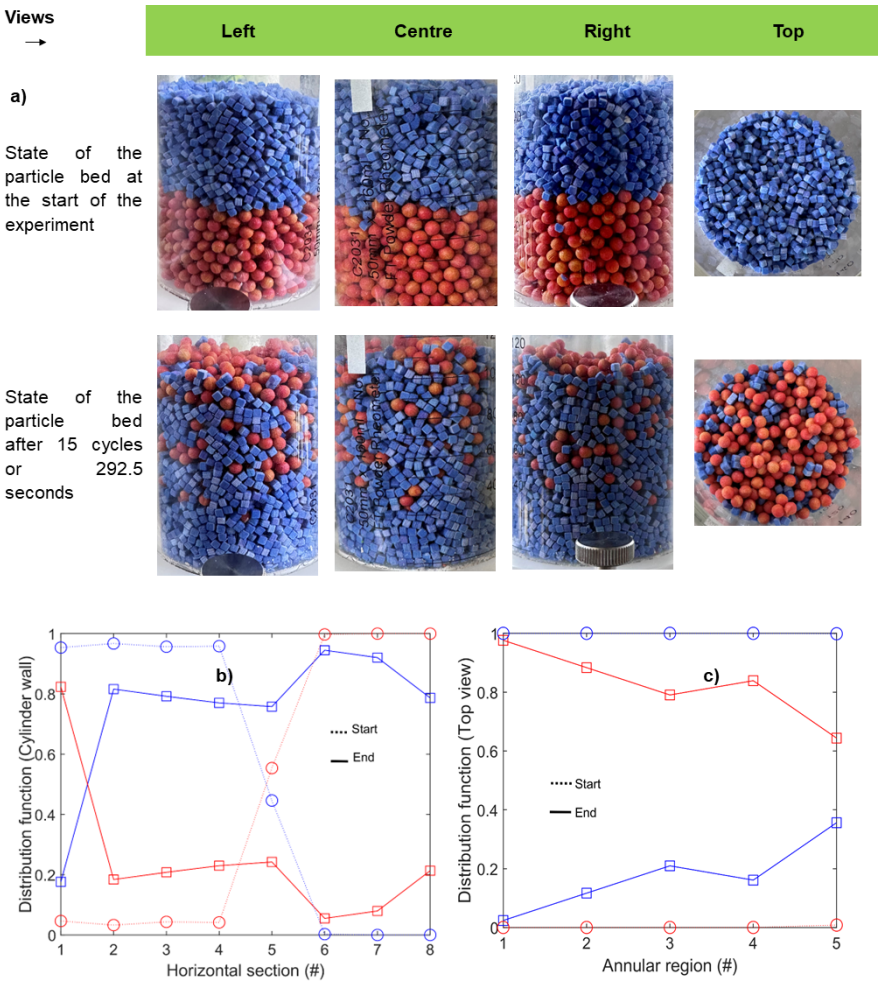


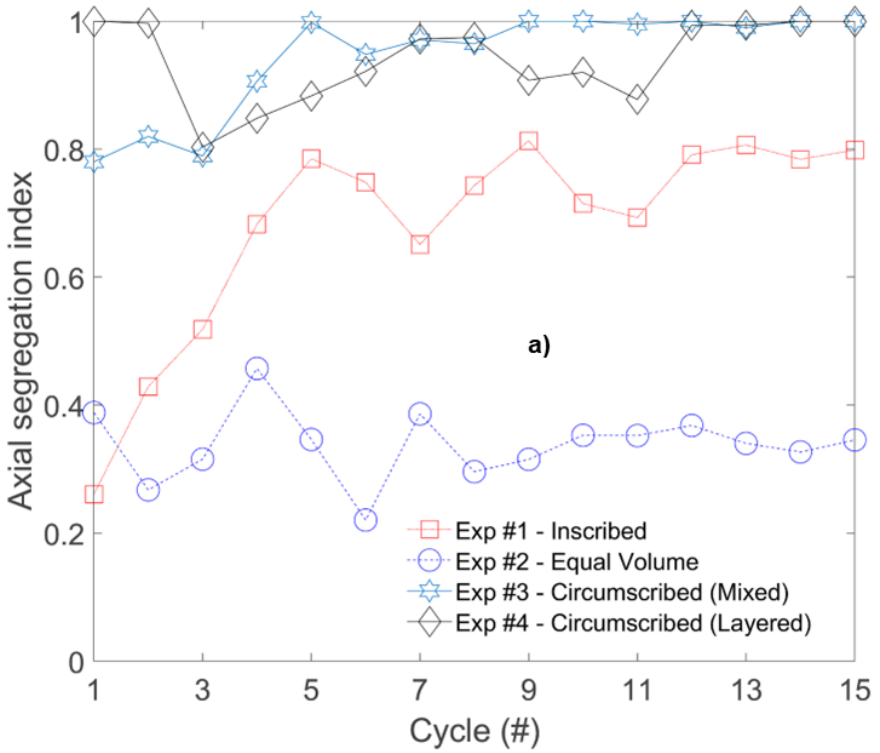
Figure 2 - Particles fabricated using binder jet additive manufacturing. These particles are placed on contrasting colored backgrounds to enable image segmentation. Spherical particles – a) 2mm, b) 2.5mm, and c) 3.46mm. d) Cubical particles - 2mm.

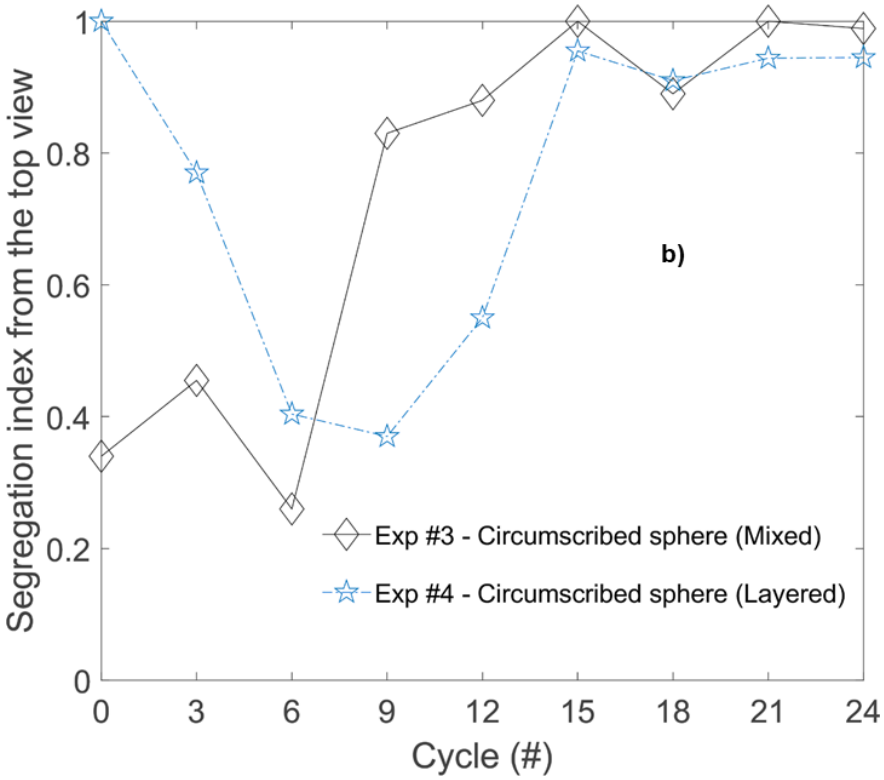






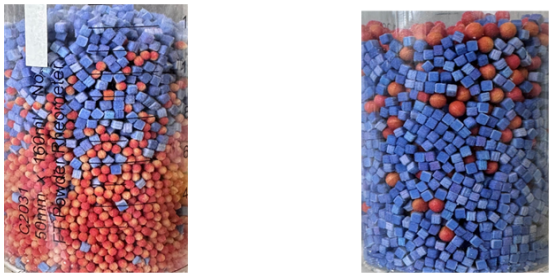






Graphical abstract

Front view of the particle bed for two experimental cases



Top view of the particle for two experimental cases

Particle distributions at the end of simulation for mixtures of different shapes (Cubes – blue and spheres - red) which predominantly exhibit, axial (left) and radial segregation (right).