Fractal packing of nanomaterials

Thorsten Poeschel
Universitat Erlagen-Nuernberg (Germany)

Cohesive particles form agglomerates that are typically highly porous. Their geometry, particularly their fractal dimension, depends on the agglomeration process—whether it occurs through diffusion-limited growth, ballistic growth via the addition of single particles, or cluster-cluster aggregation. However, in practice, the final packing structure is influenced not only by the initial formation process but also by subsequent mechanical processing.

Surprisingly, under certain process conditions, the packing structure converges to a statistically invariant form, regardless of the initial growth mechanism. We examine a process involving repeated fragmentation at a specific length scale, followed by ballistic agglomeration. Fragmentation can occur through methods such as sieving with a defined mesh size or dispersion in a turbulent fluid. Agglomeration is modeled as gravitational sedimentation.

The resulting asymptotic structure remains fractal up to the fragmentation length scale, and the fragments follow a power-law size distribution. A scaling relation links the power-law distribution to the fractal dimension.