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Effect of the size polydispersity of spherical particles on the microstructure of a random close-packing.

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Using extensive particle dynamics simulations, we investigate the random close-packed configurations of the highest packing fraction composed of polydisperse spherical particles build from the incomplete beta distribution with three parameters: a size span and two shape parameters that control the curvature of the distribution function. For each size distribution, the number of particles is determined by accounting for the statistical representativity of all particle size classes in terms of both the numbers and volumes of particles. The generated samples are subjected to a mechanical compression with frictionless interparticle contact leading to a random close-packing. We analyze the packing properties; remarkably, the packing fraction increases, up to a small variability, with an effective size span, known as the coefficient of uniformity, that combines the three control parameters of the distribution. The local particle environments are found to be characterized by particle connectivities and anisotropies, which unveil the class of particles with four contact neighbors as the largest class with an increasing population as a function of size span, indicating the higher stability of particles trapped by four larger particles. As a result of increasing topological inhomogeneity of the packings, the force distributions get increasingly broader with increasing effective size span. We, finally, show that larger particles do not always carry stronger average stresses, in particular when the particle size distribution allows for a sufficiently large number of small particles.

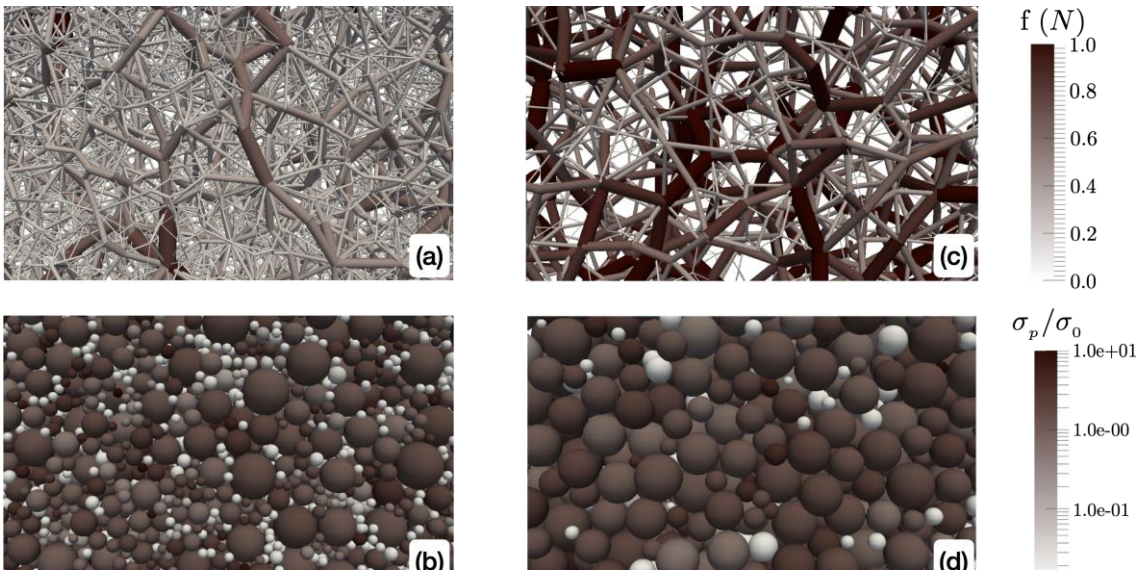

Figure 1: Snapshot of the contact force network (a)-(c) and the corresponding particles space distribution (b)-(d), respectively, for the size ration of $d/d_{min} = 5$ with two different shape parameters. Particles are colored according to the applied total stress σ_p on each particle normalized by the mean packing stress σ_0.