Modeling ultrasoft-particle media

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ABSTRACT

Soft-particle materials are common in chemical, pharmaceutical and agro-alimentary industries. Some examples of these materials are vesicles, microgels and many biomaterials. These soft-particle materials are composed of well-defined particles that can undergo large deformations without rupture. In this respect, they differ from hard-particle materials with their plastic behavior mainly governed by particle rearrangements and frictional sliding. Soft particles can reach high packing fractions by particle shape change and flow plastically due to sliding [1]. The compaction, volume change behavior under shearing and the properties of the resulting complex textures in soft packings above the random close packing state have basically remained unexplored due to the lack of proper numerical and experimental tools.

In this work, we present a detailed investigation of the compaction process of 2D soft-particle assemblies by means of a new approach combining the *Material Point Method* (MPM) for particle deformations and the *Contact Dynamics* (CD) method for the treatment of frictional contacts between particles [2]. This approach is based on an implicit formalism of MPM. Each particle is discretized by a collection of material points. The information carried by the material points is projected onto a background mesh, where equations of motion are solved. The mesh solution is then used to update the material points. The implicit formulation allows for numerical stability and efficient coupling with implicit modeling of unilateral contacts and friction between the particles. We analyze the uniaxial compaction of a small stack of elastic particles and the relationship between particle shape change and the evolution of packing fraction; see Fig 1. We show that the packing fraction beyond the random close packing state is a logarithmic function of the compressive stress. Interestingly, the friction appears to enhance the compressive stress, which leads to higher particle shape change and hence higher packing fraction.

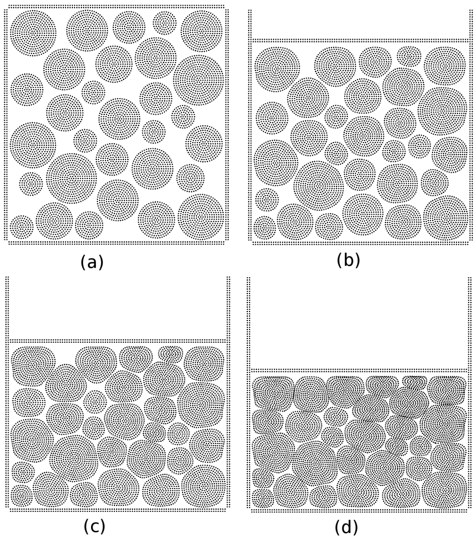

Fig.1: Four snapshots of the compaction of a packing of elastic grains; E = 10 MPa and v = 0.4.

REFERENCES

[1] M. van Hecke, "Jamming of soft particles: geometry, mechanics, scaling and isostaticity". *J. Phys.*, 22: 033101, 2010.

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