Ordering of hard cubes by shearing. An experimental study

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We experimentally analyse the compaction dynamics of an ensemble of cubic particles submitted to an alternating shear stress instead of the standard tapping procedure used in granular materials. Under this agitation, the development of shear forces among the different layers of cubes leads to particle alignment (The initial and final state is shown in Fig. 1). The control parameter (Γ) is the maximum tangential acceleration normalized with the gravity in order to compare with tapping experiments.

As a result of the twisting, the packing fraction grows monotonically with the number of twists, N. If the intensity of the excitations is sufficiently large, an ordered final state is reached where the volume fraction is the densest possible compatible with the boundary condition. Global order ir characterized by the cubatic order parameter, S_4, and the spatial order by an angular correlation function, G_4, see Fig. 2. The ordered final state resembles the tetratic or cubatic phases observed in colloids.

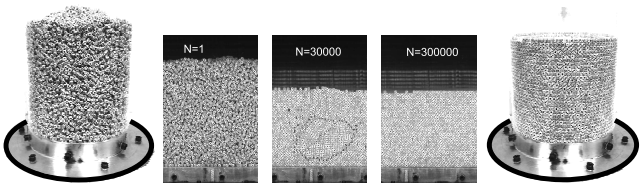

Figure 1: Experimental cell. Pictures showing the initial (left) and final (right) states for a layer of cubes submitted to 300000 twists. Image reconstruction (in the middle) corresponding to different twist number.

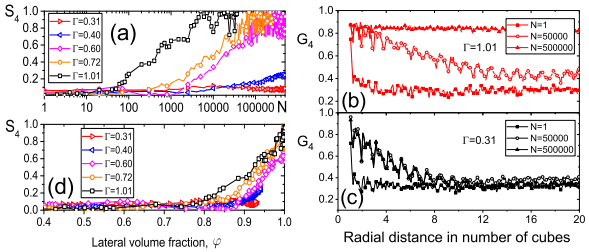

Figure 2: (a) Cubatic index S_4 as a function of the number of twists (b) The orientational correlation function G_4 for the smaller ($\Gamma = 0.31$), and largest (c)$\Gamma = 1.01$) intensity of twist studied.(d) The different Cubatic index can be collapsed is are represented against the lateral volume fraction,φ.

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