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Wrinkling crystallography on curved surfaces

Abstract

We study the crystallography of dimpled patterns obtained through wrinkling on a curved surface through a combination of precision model experiments and computer simulations. Our system comprise a doubly-curved thin shell that is bound to an equally curved compliant substrate, and the pattern emerges when the ensemble is compressed. We consider spheres, ellipsoids and tori and focus on the effect that curvature has on the topological defects of the dimpled crystal, over a wide range of system sizes. Regarding the dimples as point-like packing units produces spherical Voronoi tessellations that are used to analyze the structure and statistics of the crystalline defect for the various geometries. Disclinations are observed and, above a threshold system size, self-organized chains of dislocations proliferate rapidly. Our results show that the relationship between number of defects and system size is similar for all three geometries. On the other hand, the location of both defects and chains, as well as their orientation, depends strongly on the local Gaussian curvature and its gradient over the surface. Our wrinkling system exhibits striking similarities with other curved crystals of charged particles and colloids. Some differences are also found and attributed to the far-from equilibrium nature of our system.