Behavioral Study of Crumpled Wire in Three Dimensions

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The behavior of crumpling a long piece of wire into a three dimensional container is studied. Previous studies on wire crumpling at two dimensions have shown the importance of friction and plastic yielding on the morphology of the crumpled wire and it was found that the potential energy and insertion force follow a power law as a function of the packing density. In this study, experiments were done with nylon wires of various thickness being pushed into spherical plastic containers of varying sizes. The morphology of the crumpled structure, the maximum packing ratio, and the required wire insertion force are further investigated and confirmed with the aid of a three dimensional discrete element simulation. It is further found from the simulation that the maximum pressure exerted by wire on container and maximum potential energy of the system is dependent on the friction between wires and friction of wire with the container. Divergence of potential energy, contact energy, pressure on container and insertion forces are observed.