Retroreflector Element with Frequency and Polarization Selectivity used as a Radar Target for Granular Material Research

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In the field of granular material flow, scientists are conducting experiments to determine particle sheer dynamics in large volumes. The experiments involve thousands of particles (extremely small and generally spherically-shaped) which could vary in size and density. Based on the particle properties the experiments yield interesting formations such as "sheer bands" (which are the collection of like-particles in defined bands). Scientists are interested in being able to predict these formations given particle properties. Methods have been developed to simulate these experiments but the validation of these methods is extremely tedious. To automate the experiment validation, a real-time target tracking radar system is being developed by research groups at University of Illinois, University of Minnesota and University of Wisconsin. This portion of the work focuses on the radar target, which is a retroreflector element. The retroreflector consists of three perpendicular conducting plates. The retroreflector will be placed in capsule and sealed, so that the encapsulated retroreflector mimics the ordinary particles in both size and density.

The retroreflector element provides a strong backscatter for fields incident from any direction. Other advantages of using retroreflector elements include cost and ease of manufacture. The encapsulated radar target will have size limitations (and therefore limits on its radar cross section (RCS)) that are dependent on the size of the ordinary particles under test. The encapsulated target will be surrounded by the particles and will mostly likely be buried several layers deep. The principal planes of the retroreflector have unique surfaces that provide information in the backscattered signal as to what the relative rotation of the particles (by virtue of the fact that the target mimics the ordinary particle). By including a frequency/polarization surface on the retroreflector, its relative rotational movement can be determined. This work explores various element types and array topologies that make up the frequency/polarization selective surface. The data extrapolated from the radar target element should provide granular material scientists with invaluable information on the rotational dynamics that take place in large volumes, which is currently not attainable using their current experimental methods.