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Triboelectric charging of powder carried by an airflow

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Abstract:

During contact between materials, the exchange of electric charges, known as the triboelectric effect, occurs widely in both natural and industrial systems. It plays a critical role in phenomena ranging from volcanic ash electrification to static buildup in industrial processes. In granular materials, where countless collisions occur, this effect becomes significant, leading to adhesion, clustering, or even electric discharges sometimes resulting in explosions. Despite its ubiquity, the triboelectric effect remains poorly understood, and experimental data are crucial for advancing models and theories. In this presentation, we investigated the triboelectric effect in granular materials transported by an airflow. Using a small-scale custom 3D-printed wind tunnel, we systematically examined the influence of material type, particle size, mass and airflow velocity on triboelectric charging. We show that both the magnitude and polarity of triboelectric charging are strongly dependent on these parameters. These findings extend previous work by providing quantitative insights into charging behavior under controlled dynamic conditions, offering a new framework for understanding particle electrification in motion. This could lead to breakthroughs for controlling particle adhesion and mitigating unwanted triboelectric effects in industrial processes, such as pneumatic conveying in pharmaceuticals, food processing, and manufacturing. Furthermore, this work provides a foundation for understanding triboelectric phenomena in natural systems, such as dust storms, where similar conditions prevail.

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