IFPRI PROJECT / REVIEW BRIEF TEMPLATE

1.0	(Working) Title	Tribo-electric charging and powder agglomeration
1.1	Project or Review	Project
1.2	Technical Area[1]	Characterization, Formation, Dry Flow
2.0	Submitted by	F. Francqui, P. Mort,
2.1	Member company	Granutools
2.2	Idea creation date	10-June-2022
2.3	Last modified	14-June-2022
3.0	Short goal description	Experimental and numerical investigation of charge distributions created in a powder flow, and the contribution of these charges to tribo-agglomeration.
3.1	Objectives	The main motivation is to better understand the fundamental mechanisms leading to triboelectric charge build-up in powders during flow. The spatial distribution of charges on fine particles will be investigated. The influence of these charges on powder behavior will be analyzed vis-à-vis the effects of electrostatic cohesion on soft granule formation. Experimentally, the GranuCharge instrument measures net charge of a powder sample after flowing in contact with a selected material. This measurement enables prediction of powder charging in a handling process. The experimental objective of the proposed project goes one step further by investigating the distribution of charges inside the powder. For that, an electric field will be applied at the output of the V-tube charging the grains (before the Faraday cup) and the motion of the grains will be analyzed with an ultrafast camera to estimate the charge present on individual grains. Model materials will be selected for susceptibility to charging and size – small enough to agglomerate, and large enough for tracking, e.g., Z150 zirconia (St. Gobain). This experimental approach is complemented by simulation of the same process (grain tribo-charging in the V-tube and deviation in the electric field) using a DEM code adapted to create donor/acceptor patches on the grains via Voronoi tessellation. During flow, charges are exchanged between patches in contact; and the resulting Coulomb interactions modify the flow.

[1] One or more from the following list: W = wet systems; D = dry systems; F = particle formation; SR = size reduction; M = modeling; SE = systems engineering

3.2	Scope and Context	When two materials are rubbed, electric charges are exchanged at the surfaces. While the triboelectric effect is a fundamental scientific subject, its fundamental mechanisms are not fully understood. Even the basic question related to the nature of the transferred charges (electrons, ions or material) is still debated. **The mechanism and the distribution of the charges inside a powder need deeper investigation.** Practically, tribo-electrification in powders induces agglomeration, segregation or adhesion to surfaces. In addition, electrostatic discharge can lead to fire and dust explosions. On the other hand, triboelectrification is used advantageously in electrophotography, powder coating and separation processes. **Better understanding of the triboelectric mechanism is necessary to improve processes and avoid problems.** Over the last decade, fundamental studies have given new insight on the triboelectric effect. A mechanism of triboelectric charging based on patchy surfaces was proposed by Apodaca et al. [1]. A surface model comprising acceptor and donor sites was confirmed by Baytekin et al. [2] using Kelvin force microscopy. Concerning the nature of patches, water is a good candidate as it is composed of H^+ and OH^- ions that can transfer from wet to dry patches on surfaces [3]. In the group of G. Lumay at U. Liège, triboelectric powder properties have been studied in both experimental and numerical investigations with a fundamental and also an applied approach [4,5]. The experimental investigations led to the development of GranuCharge instrument commercialized by GranuTools and used in many applications [6]. [1] M. M. Apodaca *et al.*, Contact electrification between identical materials, Angewandte Chemie International Edition, 2010. [2] H. T. Baytekin *et al.*, The mosaic of surface charge in contact electrification, Science, 2011. [3] L. S. McCarty *et al.*, "Electrostatic charging due to separation of ions at interfaces: contact electrification of ionic electrets," Angewandte Chemie International Edition, 2008. [4] A. Rescaglio *et al.*, Tribo-electrification of pharmaceutical powder blends, Particulate Science and Technology (2019). [5] G. Lumay *et al.*, Influence of mesoporous silica on powder flow and electrostatic properties on short and long term, Journal of Drug Delivery Science and Technology (2019) [6] G. Lumay et al. , Method to measure the ability of a flowing powder to electrostatically charge and measurement device, US 10677753 B2, EP 2993468 B1
4.0	Contractor(s) with contact information	Prof. Geoffroy Lumay, University of Liège, Belgium http://www.lumay.be/ Geoffroy.Lumay@uliege.be
4.1	Comments	Brief is targeted to a single PI