The application of an electrostatic powder flow (EPF) sensor for the dynamic electrostatic charge measurement of pharmaceutical powders

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INTRODUCTION

- Tribo-electrification results from electrostatic charge transfer due to collisions between particles and the process, which can lead to number of implications (shown below in Fig. 1). Electrostatic charging is usually quantified using a simple Faraday Cup which produces only a single 'static' measurement (Pu, et al., 2007; Šupuk, et al., 2012), whereas tribo-electrification is a dynamic phenomenon influenced by flow rate and environmental conditions.
- In this study, a methodology was developed using an in-line electrostatic powder flow (EPF) sensor for the purpose of: a) identifying the dynamic intrinsic charge of different powders specific to a pharmaceutical process, and b) detecting the onset of tribo-electrification during processing.

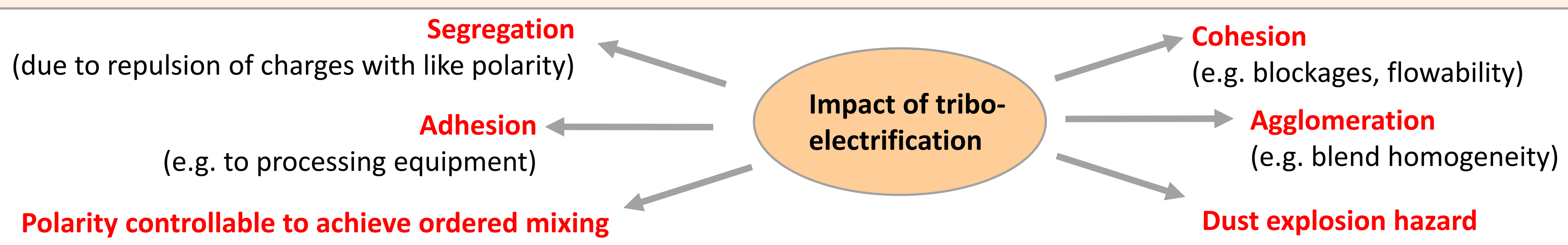


Fig. 1. *The impact of tribo-electrification in relation to pharmaceutical processes.*

MATERIALS & METHODS

a) Electrostatic measurements were recorded for five common tableting excipients and one API, conveyed (as received) at 100rpm through a volumetric twin-screw feeder (T20. K-Tron) at ambient conditions.

- The Root-Mean-Square (RMS) of the electrostatic signal was normalised against the mass flow rate over a period of consistent flow to identify the process-specific intrinsic charge for that powder.

b) The effects of material charging were demonstrated using Avicel PH102, dried for 24 hours at 100°C, then conveyed using the same operating parameters above.

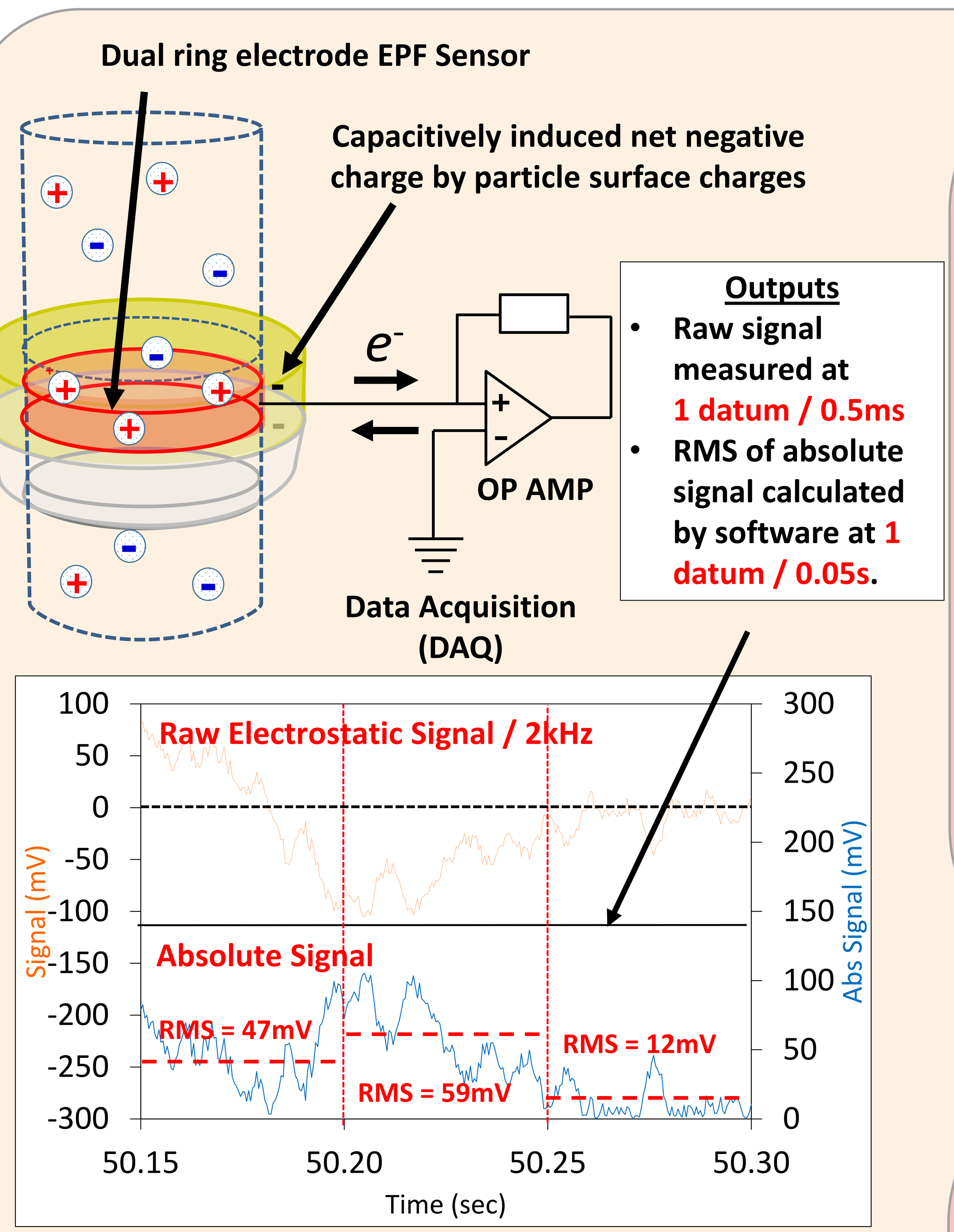


Fig. 2. *EPF sensor measurement principle and signal outputs.*

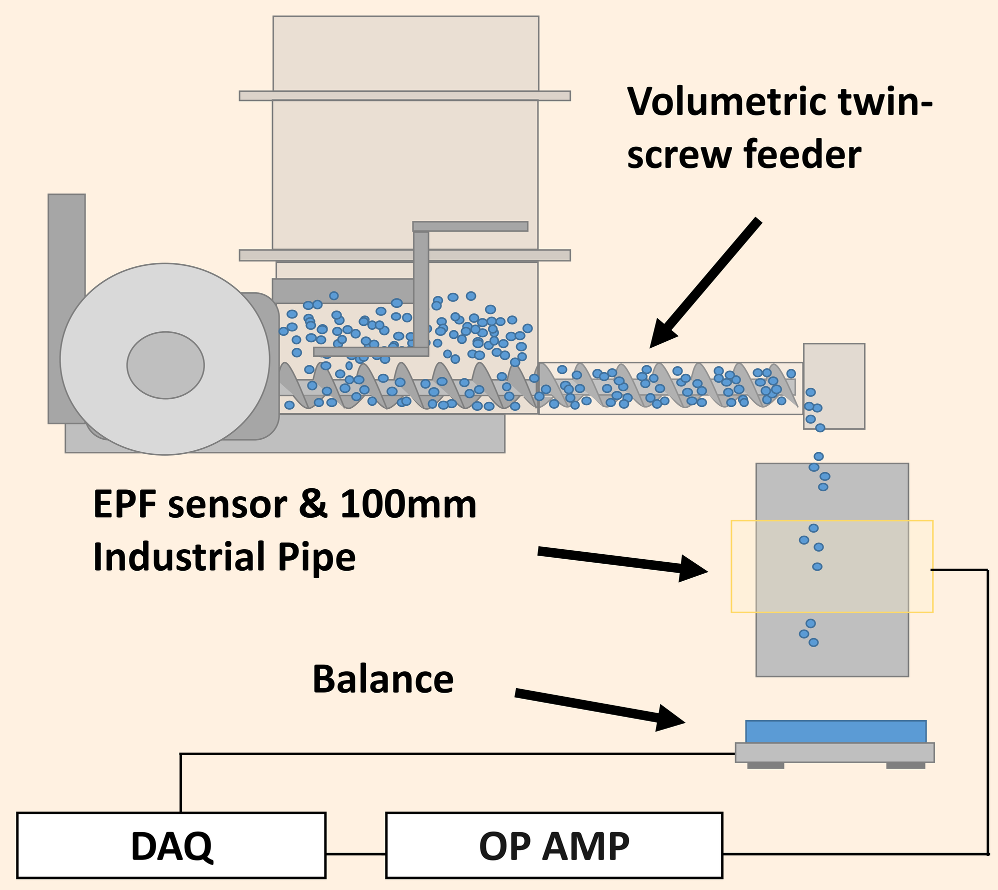


Fig. 3. *Schematic of screw feeder and EPF sensor setup.*

Table 1. *Mean normalised RMS against mass flow rate materials conveyed through the twin-screw feeder (n=3).*

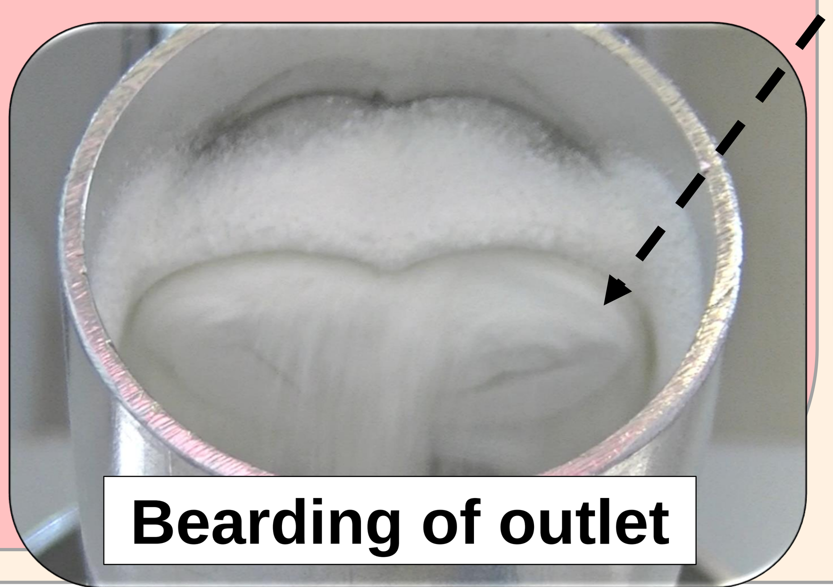
Material	Mean normalised RMS against mass flow rate (mV/g^{-1}s)
Lactose 200M	160 ± 14%
Avicel PH102	40 ± 6%
Avicel PH101	30 ± 10%
Maize Starch	16 ± 8%
Lactose #316 Fast-Flo	5 ± 9%
Compap-L	5 ± 11%

RESULTS & DISCUSSION

a) In Table 1, it is shown that lower charges were recorded for coarse materials (Lactose #316 Fast-Flo and Compap-L). Higher charges were recorded for materials with a smaller particle size (Lactose 200M, Avicel PH102 and 101).

- Potential for use as a pre-screening development tool for excipient selection, based off charging behaviour for relevant processes, e.g. blending (Šupuk, et al., 2012).

b) Fig. 5 captures the onset of tribo-electrification of dried Avicel PH102 which resulted in bearding of the screw-feeder outlet (~30s), which was followed by a relaxation and equilibration in charge.



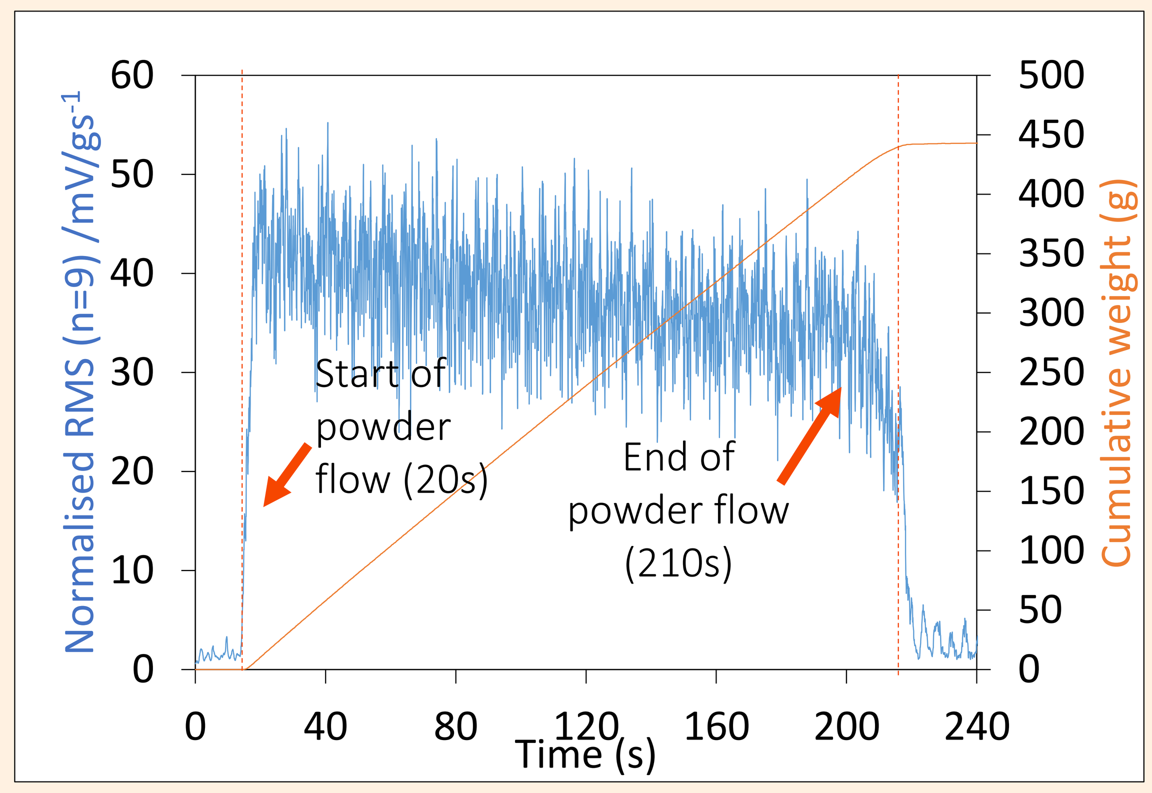


Fig. 4. *Normalised RMS and cumulative weight of Avicel PH102 "as received", conveyed at 100rpm through a twin-screw feeder, as a function of time.*

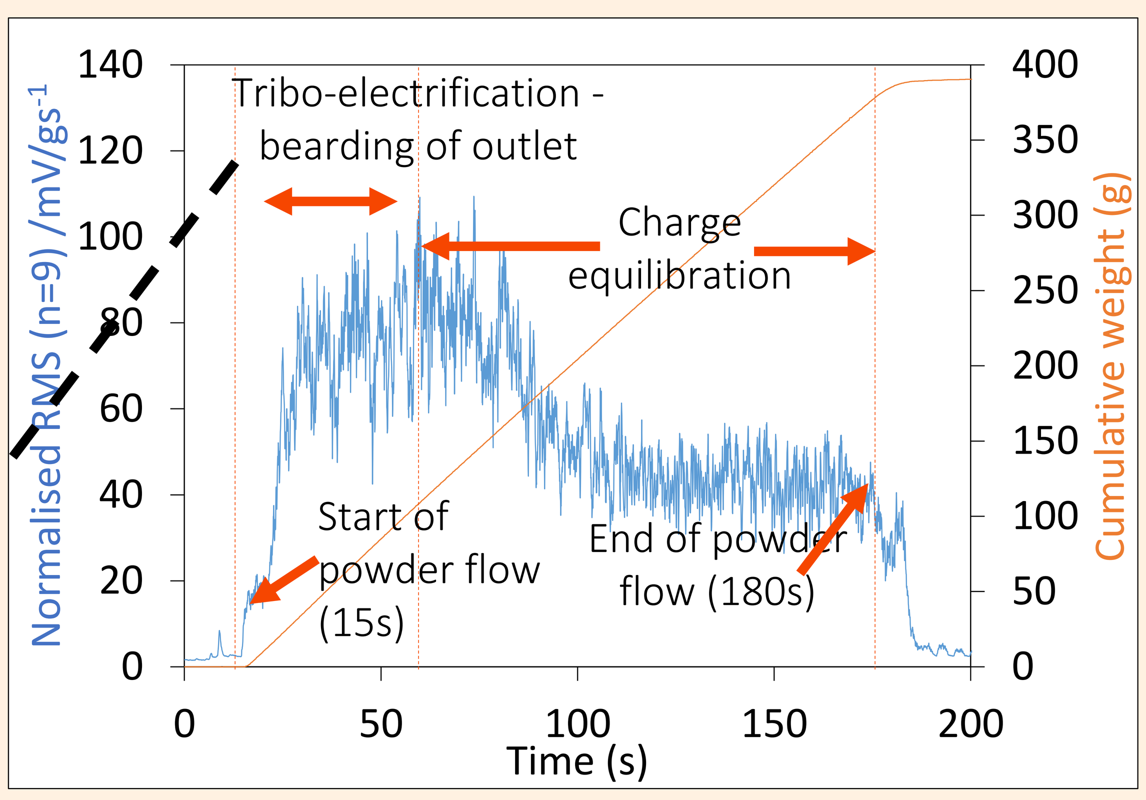


Fig. 5. *Normalised RMS and cumulative weight of dried Avicel PH102, conveyed at 100rpm through a twin-screw feeder, as a function of time.*

CONCLUSIONS

- In this study, a methodology that could predict the intrinsic charging behaviour of individual materials and the onset of tribo-electrification using an EPF sensor was presented.
- It was hypothesised that the differences in intrinsic charging propensity may be given due to differences in material attributes (e.g. particle size, shape, chemistry, moisture content, etc.).
- Tribo-electrification of a material, which resulted in adhesion to equipment, was captured in the RMS signal.

REFERENCES

- Pu, et al., 2007. Effects of electrostatic charging on pharmaceutical powder blending homogeneity. J Pharm Sci. 98, 2412-2421.
- Šupuk, et al., 2012. Tribo-electrification of active pharmaceutical ingredients and excipients. PowderTech. 217, 427-434.