DIELECTROPHORESIS AFFECTS PARTICLE MOTION IN ELECTROSTATIC TRAVELLING WAVES: A POTENTIAL APPLICATION FOR LUNAR SOIL BENEFICIATION. Y. Yu[1], K. Hadler[2], J. Cilliers[1], S. Starr[3] and Y. Wang[1], [1]Resource Geophysics Academy, Imperial College London (Imperial College London, Exhibition Road, SW7 2AZ UK and yy2120@ic.ac.uk), [2]European Space Resources Innovation Centre (41, rue du Brill, L- 4422 Sanem, Luxembourg and kathryn.hadler@list.lu), (j.j.cilliers@imperial.ac.uk), [3]Department of Earth Science and Engineering, Imperial College London (s.starr@imperial.ac.uk), (yanghua.wang@imperial.ac.uk).

Introduction: Electrostatic travelling wave (ETW) systems have gained considerable attention for their ability to transport particles across a surface, making them ideal for applications such as dust mitigation on solar panels [1] and the manipulation of dust particles on the Moon [2]. ETW systems control the motion of particles by manipulating the Coulomb and dielectrophoresis forces. Dielectrophoresis (DEP) is defined as the motion of particles by the action of a polarization force [3]. Particles only experience a DEP force when the electric field is nonuniform.

Figure 1 compares DEP and Coulomb forces acting on ballotini particles of various sizes and a charge of 1% of the saturation charge. While the forces are of a similar magnitude, the DEP force becomes more dominant as the particle size increases.

Experimental and Simulation results: The experiments and simulations show that the DEP plays a significant role in particle behaviour in ETW systems. Results have confirmed that smaller particles tend to move in the direction of the travelling wave, but also that larger particles move in the opposite direction (backward) to the travelling wave.

Figure 2 displays the tracking trajectories of three particles using superposed frames from a high-speed camera video. Small particles tend to be levitated and travel along the waves, while large particles move backward due to the effect of DEP and high frequency.

Separation results: To test the separation capabilities of ETW systems, a mixture of 1.0 g of 300-400 µm and 1.0 g of 70-110 µm ballotini particles were used. The separation test, as shown in Figure 3, produced a concentration of 89% and 90% for large and small particles, respectively, at each end of the electrode system, demonstrating successfully the size separation of the particle mixture. This capability could have important applications in the beneficiation process of In-Situ Resource Utilization (ISRU).

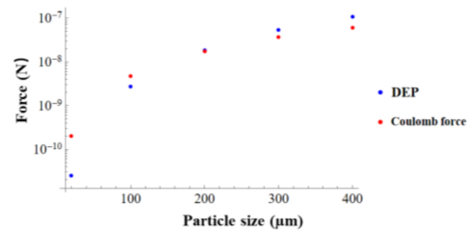

Fig. 1. Comparison between DEP and Coulomb force

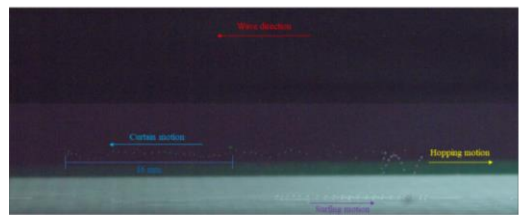

Fig. 2. Superposed frames showing particle motion

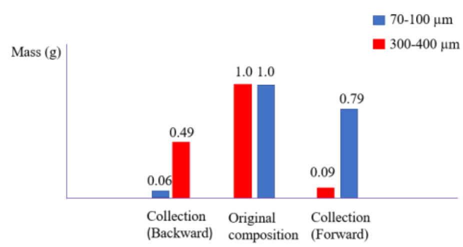

Fig. 3. Particle separation results

Conclusions: Our research has revealed the significant effect of DEP for particle backward motion near the electrode surface, making it a crucial factor in the manipulation of particles in ETW systems.

We have demonstrated experimentally the successful separation of particles with different sizes using their different moving directions, highlighting the potential of ETW systems for use in the beneficiation process ISRU. Our findings contribute to the growing body of knowledge on particle manipulation and separation using non-mechanical means, particularly in the space environment where conventional methods may not be feasible.

References:

[1] M. Mazumder et al. (2019) (*PVCS*) *IEEE XLVI*, 3269–3276. [2] M. Adachi et al. (2017) *J. Electrostat.*, *89*, 69–76. [3] H. A. Pohl (1951) *J. Appl. Phys.*, 22, 869-971.