Title: Dielectrophoretic adhesion of 50-300μm sand and alumina particles under ambient atmospheric conditions

Event: Dielectrophoresis 2014

Authors: J M Smallwood, M Praeger, R Chippendale, P Lewin

Abstract:

There are applications that require temporary adhesion of particles to a surface, including temporary printing where the 'ink' is intended to be easily recovered and subsequently reused. One possible approach is through the use of dielectrophoretic force to attach coloured solid "ink" particles under the control of a voltage applied to an electrode pattern.

Dielectrophoretic theory predicts that dielectrophoretic force is proportional to particle volume. In the circumstance where this force opposes gravitational force, this makes the balance of forces on a particle insensitive to particle size. It thereby is possible to suspend surprisingly large particles using highly divergent surface fields produced by interdigitated electrodes at modest voltages.

In this work we present our initial experimental work and some supporting finite element modeling results. Modeling results were compared in terms of an "adhesion factor" that took into account the density of particles as well as dielectric constant. Alumina and silica sand particles in the size range 50-300μm have been demonstrated to adhere strongly to an interdigitated electrode pattern having circa 0.6 mm conductors and interelectrode spaces under laboratory ambient atmospheric conditions. Applied voltages of greater than a few hundred volts caused adhesion of layers and small piles of particles. The adhesion forces were sufficient to overcome gravitational force while the electrodes were held vertically and inverted. The test samples included 50μm alumina powder and 50-70 mesh laboratory sand as well as polymer materials.

In the case of larger sand particles, the particles were released on removal of the applied voltage. In the case of fine alumina and polymer particles, some material remained attached after removal of the applied voltage. The mechanism for this is not yet understood. When a fine line of 50 μm alumina powder was deposited on the electrode, the powder separated into small heaps drawn preferentially into the highly divergent field in the interelectrode spaces. In cases where the electrodes were supported on a thin polymer foil, particles could also be made to stick to the reverse (non-electrode) side.

Acknowledgement:

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 605299.

References:

Pohl H A. (1978) Dielctrophoresis. Cambridge University Press. ISBN 0 521 21657 5

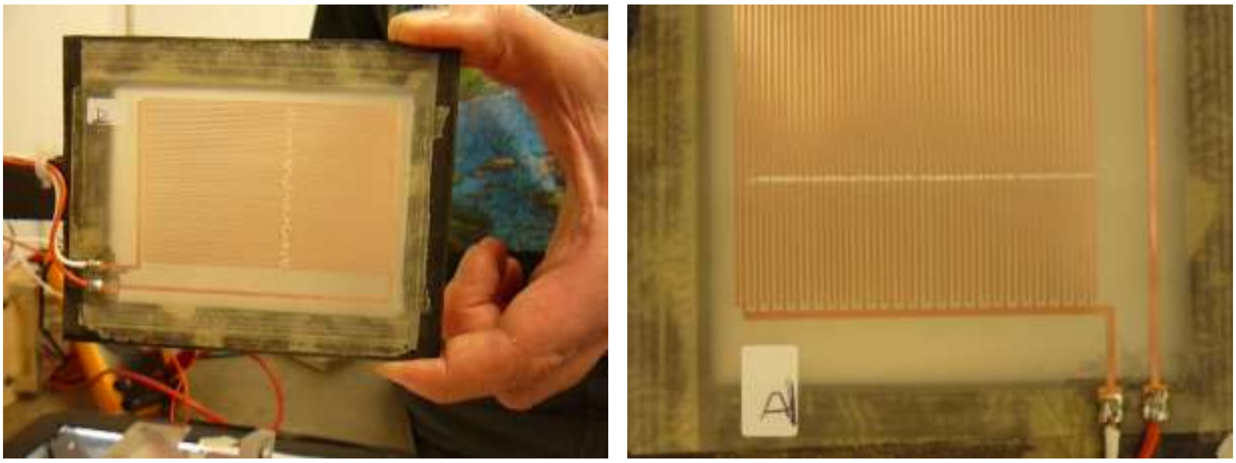

Figure 1. Sand (50-70 mesh, left) and alumina powder (50µm, right) adhering to interdigitated electrode. Applied voltage 1000V.

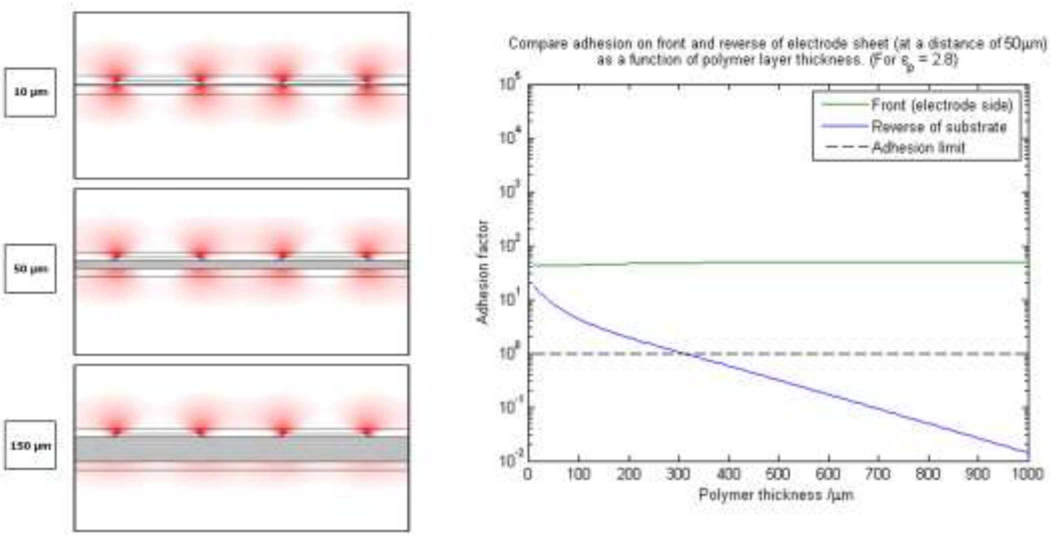

Figure 2. Adhesion factor for particles at front and rear of thin foil as a function of foil thickness. Red areas indicate zones of strong adhesion (adhesion factor >1)