TONER PARTICLE TRANSFER RESULTING FROM ALTERNATING ELECTRIC FIELDS

R.. Hoffmann[a] and **G. Wachutka**[b]

[a]Oce Printing Systems
D-85581 Poing, Germany
rainer.hoffmann@ops.de

[b]Institute for Physics of Electrotechnology
Munich University of Technology
D-80333 Munich, Germany
wachutka@tep.ei.tum.de

Many industrial printing processes use electric fields to control the transport of charged particles across small air gaps. In our work we analyzed in detail the transfer of charged, densely distributed toner particles from one roller to a neighboring one by appropriately adjusted electric field forces. To this end we performed microscopic many-body simulations using the discrete element method [1], where all relevant forces like Coulomb interaction, particle-roller adhesion and external electric field forces were accurately included in the underlying physical model.
The results of the simulation were compared to equivalent experiments, where the transferred toner layers were characterized by optical and scanning electron microscopy. The experiments revealed that the transfer mechanism is very sensitive to the nature of the applied electrical field: A DC voltage can only transfer a small fraction of the particles [2], whereas an AC voltage is able to transfer almost all the particles.
The simulations showed that for an explanation of this phenomenon it is necessary to include also the formation of the particle layer in the model. This implies the consideration of layers where the particle properties mass and charge are distributed inhomogeneously, so that the particles that are detached first by the electric fields have the highest charges. Exposed to the electric field these initially detached particles gain considerable momentum due to their high charges. The difference between a DC and an AC bias results from the fact that the particles following an alternating electric field are bouncing back on the original layer by which a certain part of the mechanical momentum is transferred to other particles. In this way, additional particles are detached so that the total number of particles rises with every period of the applied AC voltage.
After including the formation of the initial particle layer the results from the many-body simulation (amount of particles transferred, size of transfer area) conform well with the observed experimental findings. Since field-induced toner particle transfer is the central mechanism of any printing process, its detailed visualization and understanding on the basis of „virtual experiments“ on the computer has proven to be very useful for the further improvement of existing printers (e.g. speed, print quality) and for the optimized design of new printer generations, such as color printers.

References

[1] P. Cundall and O. Strack. A discrete numerical model for granular assemblies. *Geotechnique*, 29(1):47–65, 1979.

[2] R. Hoffmann and G. Wachutka. Electrical field induced particle transfer. In *Proc. of Intern. Conference on Modeling and Simulation of Microsystems*, page 258. Nano Science and Technology Institute, 2002.