An Experimental Study on the Electrostatic Projection of Particles in Production of Coated Abrasive Articles

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***Abstract*—Electrostatic projection of abrasive particles and grains using high-intensity electric fields has long been used in industry for production of abrasive articles. Despite the widespread use of this application, there are still some fundamental areas that are not thoroughly studied. In this work, we experimentally investigate the projection of non-conducting (alumina) spherical particles in an environmentally-controlled test chamber, in which deposited particles on a bare electrode are exposed to an established electric field, are inductively-charged, then take off and attach to the top adhesive layer. We try to quantify the behavior of particles as a function of applied electric field and relative humidity (RH) conditions.**

Using a high-speed video camera, we captured the motion of particles from the moment that the electric field is applied until the levitated particles attach to the adhesive layer. By analyzing the captured videos, we extracted some detailed information such as projection time, defined as the amount of time that it takes for a particle to be levitated from the surface of electrode, flight time, location, and velocity of particles at each time instant. By plugging the extracted information in the equations of motion, the electric charge of the particle was calculated using the method of least squares.

Since the size of particles plays a pivotal role in calculating their acquired charge and further analysis of their activity in the applied electric field, determining their exact size is of our great interest. In addition to using a high-speed video camera for capturing the motion of particles, we used a high-resolution camera to take still images of the lined-up alumina particles when they were manually placed on the bare electrode and before applying the electric field. A relatively large alumina particle, referred as the reference particle with a predetermined size was placed and fixed on the bare electrode using an adhesive tape. The exact sizes of alumina particles were then determined by comparing with the reference particle using an image analysis software.

We ran the projection experiments for 7 different applied voltages and 7 different relative humidity (RH) conditions in the chamber. Aside from increasing applied voltage, increasing RH also played a crucial role on projection. In very low RH conditions, we observed almost no

particle projection while the applied voltage was at its maximum value. As we increased the RH in the course of experiments, more and in some cases all the particles were projected, even at low applied voltages. It is strongly speculated that at high RH conditions, presence of water films on particle's surface, possibly in the form of small water islands, facilitate the charge exchange process. Consequently, the particles acquired the required electric charge for projection faster and projection time became shorter. In addition to the behavior of projected particles, we analyze the forces exerted on the remained to understand why they are not levitated from the surface of electrode.