# Electrospray Coating: Optimization of Process Parameters for Biomedical Applications

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**Statement of Purpose:** Natural, synthetic and a combination of both have been extensively used as implants to restore or improve the function and to supplement the strength of existing tissues. Several factors, including normal physiological outcomes affect the efficacy of implants *in situ* [1]. Thus, enhanced biocompatibility of implants is required to prevent or render innocuous potential non-specific interactions of the biopolymers with the natural body constituents. This can be achieved by changing the surface properties of the implants using superior coating techniques. An extremely uniform coating thickness is critical and the coating must have no effect on component dimensions or its functions. Several techniques used to produce biocompatible coatings on medical devices suffer from poor adhesion, composition, and need rigorous processing conditions [2]. To overcome the limitations of conventional spraying techniques we have developed a novel electrospraying technique [3]. Briefly, an electric potential is applied to a pendent droplet of the coating material solution taken in a syringe. The surface tension of the droplet tends to retain the hemispherical shape of the droplet, whereas the charge induced by the electric field tends to deform the droplet to from a Taylor cone [4]. Beyond a threshold value, the electric forces in the droplet overcome the opposing surface tension forces, and a narrow charged jet is ejected from the tip of the Taylor cone. This emerging jet may break up into droplets, a process termed electrospraying, characteristic of low viscosity solutions. These droplets are then randomly deposited on the grounded collector resulting in uniform coating. The objective of this study is to use the electrospraying technique to coat on conducting and non-conducting surfaces and optimize the coating process.

**Methods:** Poly[(50% lactic acid)(50% glycolic acid)] (PLAGA, Mw = 71,000, Lakeshore Biomaterials Inc., Birmingham, AL), tetrahydrofuran (THF) (Fisher Scientific, Atlanta, GA) were used for this study. The polymer was dissolved in THF and the concentration was varied from 0.005g/mL to 0.04 g/mL. The polymer solution was placed in a syringe fitted with a 21G needle. For the optimization studies a working distance of 30 cm and a flow rate of 4 mL/h flow rate were maintained. The morphologies of the coated surfaces were qualitatively characterized by scanning electron microscopy (SEM).

**Results / Discussion:** The aim of the present study was to evaluate and optimize the operating parameters to obtain a uniform coating via electrospraying. PLAGA concentrations of 0.03 and 0.04 g/mL resulted in dense coating and these concentrations were further used for coating experiments. A potential gradient of 1 kV/cm resulted in multilayer individual particle coating and was chosen for coating experiments. Qualitative analysis using a scanning electron microscope showed that the coated surface was uniform and has porous structures for metal slabs. Figure 1A shows an uncoated spring and figure 1B shows a uniformly and porous coating on a spring for 0.03g/mL. Higher magnification picture shows the porous coating on the spring (Figure 1C). The spring coated with 0.04 g/mL of PLAGA resulted in denser coating with reduced porous structures as shown in figure 1D. This novel technique was also used to coat non-conducting sintered microspheres and SEM pictures showed uniform and controlled thickness (Figure 1E) when compared to uncoated microspheres (Figure 1F). The thickness of the coating on all the surfaces was also varied by changing the solution flow rate and coating time.

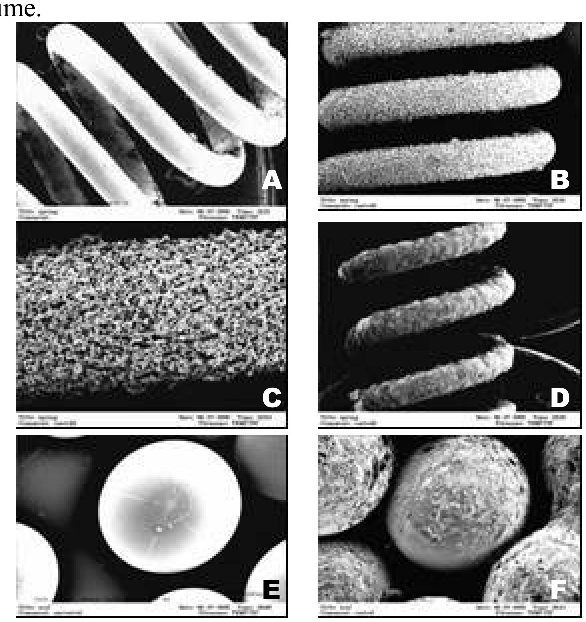


Figure 1. SEM picture showing an uncoated spring [A]; PLAGA coating on the spring at a concentration of 0.03g/mL (30X) [B] and at 100X [C]. Figure 1D shows the PLAGA coating on a spring at a concentration of 0.04g/mL (20X). Figure 1E and F shows PLAGA coating on sintered PLAGA microspheres and an uncoated PLAGA microsphere respectively.

**Conclusions:** Electrospraying is a simple, facile technique to coat micro or nano sized particles on non-conducting and conducting targets. This gives us ample opportunities for surface modifications and also drugs, proteins or growth factors can be effectively coated alone or in combination with other polymers.

**References:**

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