Drug Loading of Stents with Ink-Jet Technology

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Abstract Summary The loading of polymer-coated vascular stents with drug can be accomplished very efficiently and with good precision using ink-jet technology. The resulting stents deliver their drug payload at rates similar to those loaded by conventional spraying methods.

Introduction: Ink-jet technology is most commonly known for use in office printers; however, the controllability in microdispensing of fluids it provides is a technical advantage for a diverse array of applications[1]. In continuous mode printing, pressurized fluid is forced through an orifice, typically 50 microns in diameter producing a jet. A single frequency disturbance is applied to this jet producing droplets of extremely repeatable size. If the droplets are intentionally charged, their path of travel to the target can be controlled by an electric field. In a drop-on-demand mode printer, the fluid is maintained at ambient pressure and a transducer is used to create a drop only when needed. Both technologies can be used to load medical devices with active agents; however, this paper presents data on the use of drop-on-demand printing for loading drug-eluting stents with active agent.

Results and Discussion: Fenofibrate dissolved in isobutanol at 20 mg/ml was used as a model drug reagent solution. Programmed target deliveries of 100 μg into cuvettes gave a standard deviation of dose of 0.6 υg. Jetting on coated, uncut stent tubes exhibited 100% capture efficiency with a 1.8 μg std. dev. for a 137 μg dose. Continuous jetting off-axis to the rotating stent can yield efficiencies up to 91% and CV's as low as 2%. This is an improvement of greater than 10-fold over the efficiency of conventional spray atomization. Programmed motion control with jetting only on the outer stent surface has potential for improving the efficiency even more, which is important for many of the expensive antiproliferative drugs in use today.

Conclusion: Ink-jet technology provides a means to deliver active agents to exact locations on medical devices and do so in precise amounts with minimal waste, volatiles or degradation of the therapeutic agents

Reference: "Applications of Ink-Jet Printing Technology to BioMEMS and Microfluidic Systems" Cooley, P., Wallace, D., and Antohe, B. *Proc. SPIE Conf. on Microfluidics and BioMEMS*, p. 1, Oct. 2001.

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Figure Captions:

Figure 1. Fluorescent dye, coumarin 6, in isobutanol, jetted onto a phosphorylcholine-based (PC) polymer coating on an uncut stent tube. The droplets have spread to a diameter of 120 microns.

Figure 2. Total dosages (μg) of fenofibrate obtained on (5) PC-coated stents by reagent jetting. (control dose jetted into cuvette with solvent for comparison)

Figure 3. Model drug elution curves for 3 reagent-jetted stents using 1% Solutol, pH 4.0, 37 deg. C as the elution conditions.

Figure 1

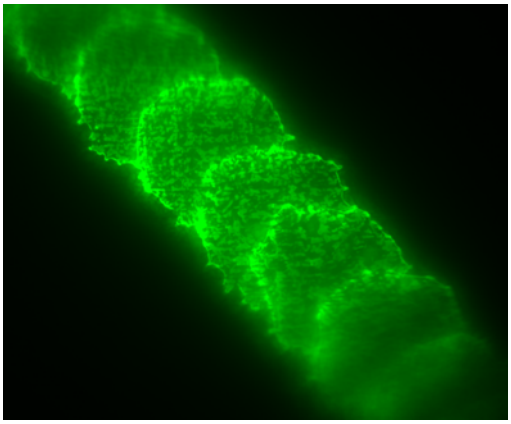

Figure 2

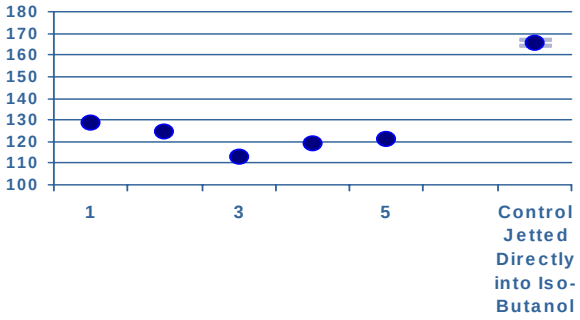

Figure 3