Real-Time Drug Release Imaging From Nanocomposite Drug and Polymer Coatings

Jinping Dong, Greg Haugstad, Chris Frethem, John Foley, Bob Hoerr, Mike Matuszewski, and Judit Puskas
Characterization Facility (UMN), Nanocopoeia Inc., Polymer Science (UAkron)

The ElectroNanospray process (Nanocopoeia, Inc) transforms drugs and polymers into many nanoscale material states including powders, liquids, encapsulated particles, and coatings. This allows application of polymers and drugs to the surface of medical devices such as coronary stents in a single-stage process. A model drug delivery system consisting of a polymer matrix (arborescent polyisobutylene-polystyrene, or arbIBS) and either dexamethasone or sirolimus was studied by various characterization techniques. Modification of ElectroNanospray process parameters resulted in surface coatings with rich morphologies that are revealed by SEM, Atomic Force Microscopy (AFM) and Confocal Raman Microscopy were employed to monitor the drug release process *in situ*, through which the mechanism of the drug-eluting process may be proposed. A Confocal Raman microscope fitted with underwater objective was used to image arbIBS/drug films incubated in phosphate-buffered saline over 12 h and at various film depths. Drug migrated from more concentrated areas into the surrounding polymer and toward the surface, beginning as early as 5 min after placing the sample in buffer and continuing throughout the 12 h period. High drug levels remained in the more concentrated areas at the end of incubation, suggesting the potential for prolonged release. SEM and AFM images taken from samples post incubation showed the appearance of nanoscale pores ~100 nm in diameter in areas corresponding in size and distribution to the Confocal Raman planar image areas of increased drug concentration. Confocal Raman microscopy offers a powerful new technique for demonstrating real-time drug release from therapeutic medical device coatings.