On-line prediction of final product properties in manufacture of a drug-eluting implant

Medical implants are increasingly seeing the incorporation of Active Pharmaceutical Ingredients (API) to reduce implant site complications and improve biocompatibility. Such molecules include antibacterial drugs, immunosuppressive drugs, anti-inflammatory drugs, or APIs that in various ways stimulate cellular proliferation and tissue regeneration. Implant materials suited for drug release purposes are typically bioresorbable polymers such as polylactic acid (PLA) which degrade over time into non-toxic byproducts while slowly but continuously releasing the drug trapped within its matrix. Ideally the polymer provides initial mechanical support (e.g. cardiovascular stent, bone fixation screw etc.) and degrades completely over time as the host tissue heal and the implant is no longer required.

Implantable medical devices are widely used in the pharmaceutical field and usually prepared by Hot-Melt Extrusion (HME). However HME of such devices is still complex and expensive with long development times - not only in the formulation of the product but also in identifying suitable process conditions and adapting to variations between batches of raw materials. Processing conditions affect the degradation of the polymer, degradation of the drug, drug-polymer interaction, dispersion of the API, the crystallinity of the drug and other factors critical to mechanical properties and drug release behaviour. The effect of process settings on these factors are not well understood and the industry is still dominated by off-line quality testing in a laboratory with very slow feedback to adjusting the process parameters.

The proposed research targets this knowledge gap by aiming to use on-line process measurements, including Process Analytical Technology (PAT) to predict key final product quality characteristics in real-time during processing using mathematical modelling techniques. The key research questions to be addressed are:

1. How do extrusion processing parameters affect the quality of extruded bioresorbable API-loaded medical implants?

2. Can in-process Raman and/or NIR spectroscopy data yield real-time insight to the structure and properties of the drug-polymer systems for the production of such implants?

3. Is it possible to use this data, with or without other process data, to predict final product quality metrics in real-time with similar accuracy to conventional off-line laboratory testing?

Candidate Profile

Candidates should hold a 2:1 or higher L8 Degree in Chemical/Process/Polymer/Manufacturing/Mechanical or related engineering discipline. Candidates with a pharmaceutical or chemistry degree will also be considered. All candidates should have excellent mathematics skills and an interest in medical device manufacturing.