July 12, 2013

Cambridge Polymer Group

Medical Implant Cleanliness: A look back at InterOp

This newsletter summarizes testing techniques, materials, and new announcements from Cambridge Polymer Group.

Custom Labview Coding

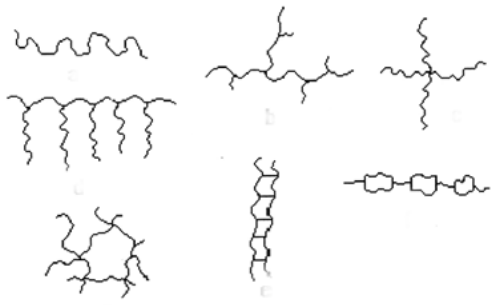
NATIONAL INSTRUMENTS LabVIEW CERTIFIED ASSOCIATE DEVELOPER

LabView®, made by National Instruments, is a versatile programming language that has good application for laboratory equipment automation, motion control, image collection, and data analysis. Engineers and scientists at Cambridge Polymer Group routinely use LabView in their design of custom analytical instruments to characterize materials. The LabView code allows the users to set up the experimental conditions, control the equipment, collect and save the data, and analyze the data. The final data set is easily viewed in Excel, Word, or other formats.

Recently, two CPG scientists completed their coursework allowing them to become Certified LabView Programmers. CPG has designed custom software for clients for existing instruments and for automated data analysis algorithms.

A link to the video from a CPG-generated LabView program that collects crack propagation lengths automatically in a Fatigue Crack Propagation test can be found here.

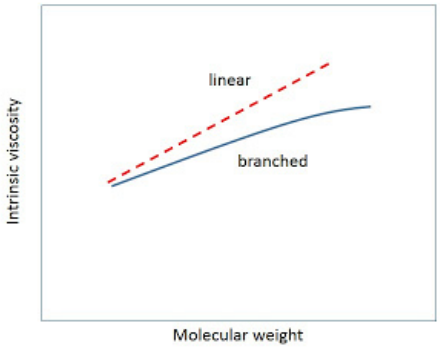
Are my polymers branched?



Polymers can be classified as linear or branched. Branched polymers contain chains hanging off the

backbone of the polymer, which could include a single side chain or multiple side chains. Linear polymers do not have branches. Branching can strongly influence the processing behavior and ultimate properties of a polymer. In the melt state, branching will increase the melt viscosity of a polymer compared to its linear analog. Branching will also reduce crystallinity in semi-crystalline polymers, as the branches partially inhibit the packing of the polymer chains. Branching can occur during polymerization due to a variety of reasons, including the use of divalent monomers, mixed monomers with different side groups, backbiting during polymerization, radiation grafting, or other reasons. Branching can also occur during processing, particularly if the material undergoes scissioning or further reaction. As a consequence, measurement of branching is important to assess process conditions and ultimate properties in the polymer in question.

Branching can be assessed rheologically, with nuclear magnetic resonance spectroscopy (NMR), and inferred with techniques that monitor end properties such as crystallinity. Detailed information can be determined by triple detection gel permeation chromatography (GPC). In this technique, a polymer is run through a standard GPC column that is equipped with a refractive index detector, a light scattering detector, and a viscometer. The refractive index detector provides information about the concentration of the polymer chains at a given elution time, light scattering provides absolute measurement of the weight-average molecular weight at each elution time, and the viscometer provides the effective density of the polymer chains at each elution time. With these measurements, a Mark-Houwink plot can be generated, as shown below. By comparing the test sample in question to a sample that is known to be a linear polymer, it is possible to assess if the material is branched. For a given molecular weight, a branched polymer will have a smaller volume and hence a reduced viscosity compared to a linear polymer. The amount of deviation from the linear analog is an indication of how much branching there is in the test sample. In this matter, the degree of branching can be calculated for each molecular weight.



A look back at InterOp

In 2000, the orthopedic community received a wake up call when one manufacturer, Sulzer, began to receive notices from surgeons that one of their acetabular shells, the InterOp, was failing to show

osseointegration in a number of patients after a few months. The InterOp was designed with a titanium porous back to allow fixation by bony ingrowth. A thorough investigation ensued to determine why osseointegration was occurring for some patients. A number of consultants and laboratories, including Cambridge Polymer Group, were enlisted in this investigation.

Following a few months of analysis, it was determined that two key manufacturing step changes resulted in the poor outcomes. Firstly, Sulzer introduced an additional lathe-turning step following the porous titanium coating sintering process. The lathe-turning step introduced a lubricating oil into the porous backing that was insufficiently removed during the cleaning cycle. Any lubricants introduced prior to the titanium sintering process would be burned cleanly away. The second manufacturing step change was the removal of a nitric acid passivation process. Passivation is normally included in metallic devices to clean away any iron-based fragments introduced by machining tools.

Cambridge Polymer Group quantified oil content on hundreds of devices, comparing the manufacturing lots where clinical failures occurred. Interestingly, the bulk of the clinical failures occurred only in lots lacking the passivation step, despite the fact that other lots with passivation had higher levels of oil as well.

In the end, it was postulated that an endotoxin residing in the oil was responsible for the lack of osseointegration. Such an endotoxin would be readily removable with nitric acid passivation.

Prior to InterOp, manufacturers and regulators paid a great deal to sterility, given that several standards were in place, most notably from AAMI. Cleanliness standards were not as prevalent, however.

In the end, patients with failed InterOps received replacement devices, and a new ASTM sub-committee was formed to develop standards for determining cleanliness of medical devices. Device cleanliness has become a standardized test for medical device manufacturers.

More information on medical device cleanliness can be found here.

Cambridge Polymer Group, Inc. is an ISO 9001:2008 certified contract research laboratory specializing in polymeric materials. We provide routine analytical testing on materials, custom test design, failure analysis, consultation, instrumentation, custom polymer and hydrogel formulation, and out-sourced research.

Cambridge Polymer Group
56 Roland Street, Suite 310
Boston, MA 02129
617.629.4400 (office)
617.629.9100 (fax)
info@campoly.com
www.campoly.com