Compressive Loading of Polyvinyl Alcohol Microbeads

The Challenge:

Resolve Small Compressive Forces Applied to a Single Layer of Hydrogel Microspheres

Background

Polyvinyl alcohol (PVA) hydrogels are used in embolization therapy, a minimally invasive treatment for hypervascularized tumors and arteriovenous malformations. During embolization therapy, an embolic material such as PVA hydrogel microspheres is injected into the selected vessels to block the blood flow feeding the tumor or malformation. This causes the tumor or malformation to gradually shrink over time.

Embolization therapy can be used to treat such health issues as liver tumors, uterine fibroids, varicose veins, and aneurysms. It offers benefits over more standard surgical treatments, including shorter hospital stays, shorter procedure recovery times, and decreased treatment costs.

Microspheres of PVA hydrogel as an embolic agent are ideal; they are well suited to the flow dynamics of the bloodstream. They are hydrophilic, can be colored for increased visibility, and are compressible. These features allow for smoother delivery to the target area of the body.

Meeting the Challenge

A manufacturer of PVA embolic agents contacted the ElectroForce® Systems Group of Bose Corporation with the challenge of accurately resolving the forces required to compress the microspheres they produce. The ElectroForce 3220 test instrument with WinTest® software was used to subject the microspheres to 80% strain in compression and accurately resolve force and displacement. The ElectroForce 3220 is a tabletop test instrument capable of measuring loads up to 50 lb (225 N) and displacements up to 0.50 in (12.5 mm).

The embolic agent manufacturer supplied the ElectroForce Systems Group with the PVA hydrogel microspheres for testing. The microspheres, in their syringe delivery device, were 700 – 900 µm in diameter.

The testing was performed in compression with platens and with the ElectroForce 3220's standard 0.5 in (12.5 mm) displacement transducer and 50 lb (225 N) force transducer.

A contained, single layer of microspheres was pipetted from the syringe delivery device onto a 2 in (50 mm) compression platen (Figure 1). Excess liquid was used to compress the microspheres.

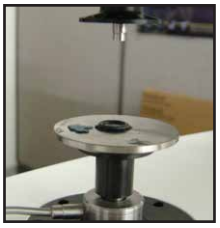

Figure 1 - Monolayer of microspheres prior to test

The test performed was a displacement ramp, subjecting the microspheres to an 80% strain at a rate of 5 mm/min.

Results

Load-displacement curves indicated that the 3220 test instrument started picking up data at approximately 650 µm, as shown in Figure 2. At 80% strain, the maximum force recorded was approximately 0.4 N.

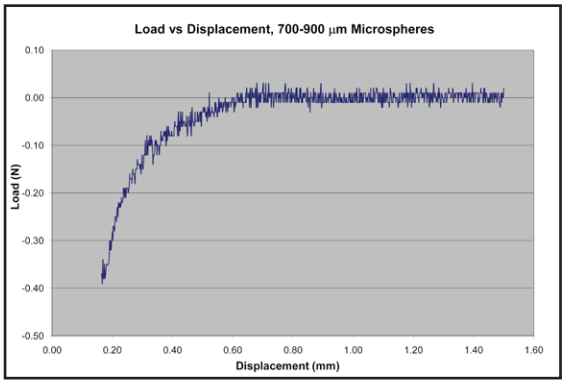

Figure 2 - Load-displacement curve

Summary

Load-displacement curves indicated that the 3220 test instrument started picking up data at approximately 650 µm, as shown in Figure 2. At 80% strain, the maximum force recorded was approximately 0.4 N.

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