Testing to Improve the Durability of Artificial Heart Valves

The Challenge:

Evaluate the Durability of an Innovative Composite Polymer-based Heart-valve Prosthesis

Background

Heart valve prostheses have been used successfully in heart procedures since 1960 resulting in an overall improvement in the quality of life of the patients. Currently, there are two kinds of valves used: mechanical and bioprosthetic. Generally, mechanical valves are more durable than bioprosthetic valves. However, they sometimes involve side effects with irregular blood flow and clotting of blood around them. Bioprosthetic valves have better hemodynamic (blood flow) properties, but are more susceptible to wear as a result of material fatigue. Polymer trileaflet (PT) valves offer natural hemodynamics with the potential for better durability.

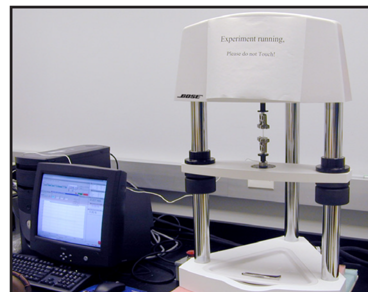
PT heart valves usually fail in long-term use with tearing and calcification of the leaflets due to high dynamic tensile and bending stresses borne by the material and the oxidative reactions with blood. It was postulated that synthetic valve leaflets that mimic the natural valve leaflet structure fabricated from fiber-reinforced composite material will minimize leaflet stresses and decrease tears and perforations.

Meeting the Challenge

The aim of the research, performed under the supervision of Dr. Richard Schoephoerster in the Cardiovascular Engineering Center at Florida International University, is to manufacture and test an innovative composite PT heart valve prosthesis.

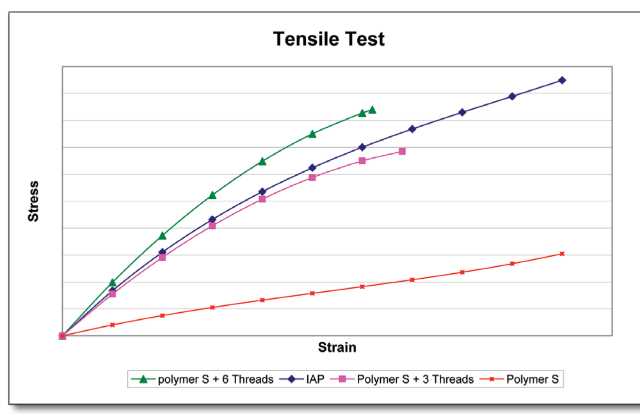
In order to identify the better material from which to manufacture valves, a certain proprietary polymer is compared to an existing implant-approved polymer (IAP). Static and dynamic properties of the polymers are being determined in order to establish the right polymer composite for the heart valve prosthesis. All the testing is performed on the ElectroForce® 3200 test instrument.

Stretched Specimen



The ElectroForce® 3200 Test Setup

Tensile and tension fatigue properties for each material are performed according to ASTM standards. The tensile test is displacement controlled, and the specimen is stretched at a constant rate until failure. The tension fatigue test is load controlled; that is, the specimen is being cycled between two tensile loads. The loading frequency is 100 Hz. Cycling continues until failure for each specimen. Since there can be significant fatigue damage without actual fracture, failure is defined as 50% loss in residual strength of the material.



Preliminary results show the fiber-reinforced composite material has the potential for longer fatigue life when compared to an existing implant-approved polymer.

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