



# Artificial Annulus Fibrosus Model

## Summary

An estimated 12 million people in the US suffer from degenerative disc disease. Recent therapies involve replacement of the nucleus pulposus (NP) with an artificial material using the existing vertebral endplates and annulus fibrosus (AF) as confinement for the implant. Testing these materials in a relevant manner is difficult because of natural tissue variability and limited life. Existing synthetic approaches using silicone rubbers are inadequate because of their poorly matched mechanical properties. CPG has developed a more relevant composite structure that will simplify fatigue testing of these devices.

## Description

The CPG AF analog has anisotropic properties and non-zero permeability to more closely model native AF tissue. Monofilament polyvinyl alcohol (PVA) fibers coated in PVA solution are wound with an approximate 30°/60° orientation into an annular ring. This fiber orientation mimics the lamellae in the natural AF and plays a large role in distribution of disc compressive load. PVA solution is then gelled around the fibers. The resultant PVA/PVA AF is a composite fiber/hydrogel that is both permeable (due to ~50% water) and mechanically anisotropic. The mechanical properties of the AF can be optimized by adjusting the PVA concentration in the gel solution, the gelation process, and the fiber characteristics. Other polymer fibers may also be substituted and the hydrogel matrix can be modified to tune the properties further.



CPG PVA/PVA AF

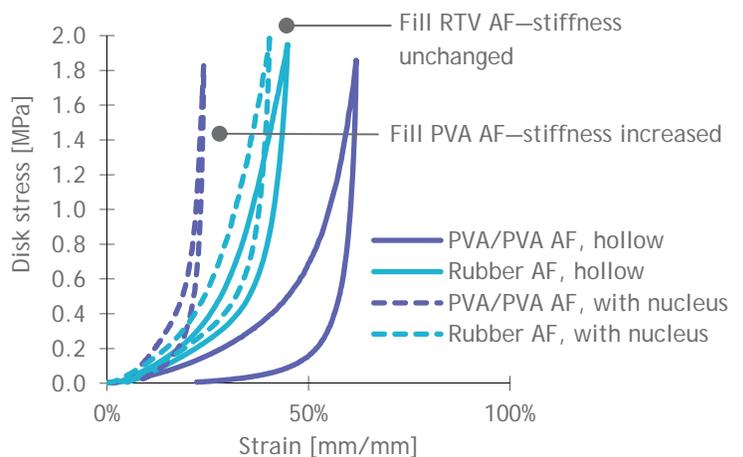


ASTM RUBBER AF



## Discussion

The compressive properties of the PVA/PVA AF were compared to the conventional ASTM rubber model in both a hollow and nucleus-filled configuration. No bowing or slipping was seen during the PVA/PVA AF compression testing; however, the rubber AFs exhibited bowing. The artificial NP approximates the mechanical properties of the native NP and translates the compressive load into a hoop stress within the PVA/PVA AF fibers.



## Applications

Improved model for bench top testing of nucleus pulposus replacements