Adults suffering from lower back pain often find the cause of pain is degenerative disc disease. While non-surgical treatment is preferred, spinal fusion and total disc replacement remain surgical options for the patient. Total disc replacement is an emerging and improving treatment for degenerative discs. This research studies effects of microstructure of a novel composite on mechanical properties and investigates the potential application in total disc replacements.

The first part of the thesis provides a review of lumbar disc replacement for treatment of lower back pain. The mechanics and configuration of the natural disc are first discussed, followed by an introduction of treatment methods that attempt to mimic these mechanics. Total disc replacement types, materials, and failure mechanisms are discussed. Failure mechanisms primarily involve biochemical reactions to implant wear, as well as mechanical incompatibility of the device with natural spine motion. Failure mechanisms at the interface are driven primarily by osteolysis. Combating osteolysis and fixation issues are the motivation for the development of this material. The second part of the thesis discusses design, synthesis, and characterization of a new composite containing pearl powder and metal alloys. The mechanical properties and tribological performance are investigated against their microstructures.

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