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PROCEEDINGS

Fabrication and Static/Dynamic Characterisation of a Hydrogel Candidate for Artificial Human Cartilage

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ABSTRACT

Arthritis, caused by degeneration and wear of articular cartilage, affects millions of patients worldwide. It can result in chronic pain, swelling, stiffness, and significantly affect the mobility of patients. Hence, identifying a material as an artificial alternative to replace damaged cartilage is of great benefit. Hydrogel, because of its high water content and similarity with the extracellular matrix of cartilage, has been explored for potential use as artificial cartilage. In this investigation, Polyvinyl Alcohol-Polyethylene Oxide (PVA/PEG) hydrogel with similar mechanical properties to human articular cartilage (e.g. compressive modulus, stress-strain response) was fabricated using a freeze-thaw approach. This hydrogel displays hyperelastic behaviour under compression – after 40% compression, it can fully recover its original state upon unloading. The hydrogel was tested under two conditions – i) dry (specimen dried at room temperature for 8 hours) and ii) submerged in water; little difference between the compressive responses for the two conditions was observed. Cyclic compression tests with a maximum engineering strain at 0.4 were also applied to the hydrogel; this showed that the hydrogel response stabilises after about 60 cycles, and the peak stress of the stabilised response is only 8% lower than the response in the first cycle. In addition, effects of strain rate on the compressive response of the hydrogel were examined, with dynamic tests performed using a direct impact Hopkinson bar device. Strong rate dependence of the hydrogel was observed – at a common strain of 0.2, the stress at 270 /s strain rate is almost double the static value. These results suggest the hydrogel has good potential for use as artificial cartilage.

KEYWORDS

Hydrogel; cartilage; freeze-thaw; strain rate

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