SELF-HEALING PMMA BIOMATERIALS

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ABSTRACT

Inspired by living systems, self-healing polymers and composites are designed to autonomically repair damage whenever and wherever it occurs, thus providing a means to significantly extend the service life and reliability of structural materials. Capsule-based approaches to self-healing have been demonstrated in a variety of polymers and composites nearly all of which are relegated to thermosetting, structural systems. Autonomic-healing of thermoplastics remains a significant challenge for this class of materials at room temperature conditions. Of particular importance is the subset of PMMA thermoplastics used in biomedical applications for bone cement and dental implants.

Here we demonstrate a self-healing bone cement using a capsule-based approach for use in medical implants. Knee and hip replacement surgeries are increasingly common, but are typically limited to a 10-year lifetime due to aseptic loosening exacerbated by fatigue damage in the cement material. Self-healing of the bone cement could significant extend the lifetime of implants and reduce the need for revision surgeries.

A self-healing bone cement is formulated using medical grade bone cement in which microcapsules (ca. 100 μm) of encapsulated healing agent(s) are dispersed. Two different healing approaches are presented including a dual-capsule free radical reaction chemistry and single capsule solvent chemistry. Fracture toughness evaluation is carried out for virgin and self-healed specimens following established protocols. The effect of capsule concentration and healing conditions on self-healing performance are elucidated.