



## Article

# Self-Photopolymerizable Hydrogel–Ceramic Composites with Scavenger Properties

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**Abstract:** The photocatalytic behaviours of semiconductive ceramic nanoparticles such as TiO<sub>2</sub>, ZnO, Fe<sub>2</sub>O<sub>3</sub>, and Fe<sub>3</sub>O<sub>4</sub>, have been extensively studied in photocatalysis and photopolymerization, due to their ability to produce radical species under ultraviolet–visible light, and even in dark conditions. In addition, in the form of microparticles, TiO<sub>2</sub> and its Magnéli phases are capable of neutralizing radical species, and a heterogeneous catalytic process has been suggested to explain this property, as it is well known as scavenging activity. Thus, in this study, we demonstrate that these ceramic powders, in the form of microparticles, could be used as photoinitiators in UV polymerization in order to synthesize a hydrogel matrix. Them, embedded ceramic powders could be able to neutralize radical species of physiological media once implanted. The hydrogel matrix would regulate the exchange of free radicals in any media, while the ceramic particles would neutralize the reactive species. Therefore, in this work, the scavenger activities of TiO<sub>2</sub>, ZnO, Fe<sub>2</sub>O<sub>3</sub>, and Fe<sub>3</sub>O<sub>4</sub> microparticles, along with their photoinitiation yield, were evaluated. After photopolymerization, the gel fraction and swelling behaviour were evaluated for each hydrogel produced with different ceramic initiators. Gel fractions were higher than 60%, exhibiting variation in their scavenging activity. Therefore, we demonstrate that ceramic photoinitiators of TiO<sub>2</sub>, ZnO, Fe<sub>2</sub>O<sub>3</sub>, and Fe<sub>3</sub>O<sub>4</sub> can be used to fabricate implantable devices with scavenger properties in order to neutralize radical species involved in inflammatory processes and degenerative diseases.

**Keywords:** photoinitiator; hydrogels; photo-Kolbe reaction



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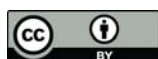
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## 1. Introduction

Semiconductive ceramic materials, such as TiO<sub>2</sub>, have been studied in terms of their scavenging activity in order to neutralize radical species in dark conditions [1–3], and have also been studied as photocatalysts [4]. Although the exact mechanism of scavenging in this ceramic has not yet been elucidated, Canillas et al. [5] suggested in a previous work that it is derived from a heterogeneous catalytic process, where unsaturated titanium or penta-coordinated titanium in the materials' surface act as active sites. The geometric configuration of preferential facets in the corresponding ceramic phases plays a key role in the activity; this is due to the accessibility of reactive and solvent molecules to the active site positions. These authors have also shown that ceramic phases of Ti<sub>n</sub>O<sub>n-1</sub> increase the catalytic activity [6], due to the coexistence of Ti<sup>3+</sup>/Ti<sup>4+</sup> and the chemistry of defects in their