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Influence of the incorporation of functionalized TiO_2 nanotubes on the properties of resins for 3D printing

Influência da incorporação de nanotubos de TiO_2 funcionalizados nas propriedades de resinas para impressão 3D

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ABSTRACT

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Introduction: Since it is a highly versatile manufacturing method that can be applied to metals, ceramics and polymers, additive manufacturing, also known as 3D printing, is rapidly gaining space in dentistry, however, there is still a great potential for improvement of the materials. **Objective:** The objective of this study was to evaluate the influence of the addition of functionalized TiO_2 nanostructures on physicochemical and mechanical properties of resins for 3D printing. **Material and methods:** Two commercially available resins where be used: Cosmos TEMP – Yller Biomaterials, Smart Print Bio Temp - Smart Dent. TiO_2 nanostructures of were functionalized with 3-Aminopropyl Trimethoxysilane (APTMS) or 3-Trimethoxysilyl-Propyl-Methacrylate (TMSPM) silanes. The incorporation of nanostructures of TiO_2 into resins was made by mechanical mixing, in mass proportions of 0.3wt% and 0.9wt%. Resins without nanotubes were used as control. With the specimens divided into groups according to the resin and the concentration of nanostructures incorporated, the flexural strength, modulus of elasticity, water solubility and sorption and color stability were evaluated. The results were analyzed using the two-way ANOVA and Tukey tests, adopting a significance level of 5%. **Results:** For the flexural strength and Young's modulus, significant differences were found between the resins used, between the presence of nanotubes and the functionalizations ($p < 0.05$). The interaction effect between resin and functionalization was also significant ($p < 0.05$). For solubility, the lowest values were observed for Smart Print Bio Temp resin with the addition of 0.9wt% of APTMS-functionalized nanotubes and the highest for Cosmos Temp resin without nanotubes. For color stability using the CIE-Lab formula after aging, significant differences were observed for resin and addition of functionalized nanotubes ($p < 0.05$). The interaction effect between resin and addition of nanotubes was also significant ($p < 0.05$). The color stability $\Delta E00$ addressed by CIED2000 showed the same trend. **Conclusion:** Flexural strength, modulus of elasticity, water sorption and color stability of resins for 3D printing were influenced by the addition of TiO_2 nanotubes functionalized with APTMS and TMSPM in the concentrations of 0.3wt% and 0.9wt%. Functionalized nanotube additives may be used to improve resinous materials used for additive manufacturing.

Keywords: 3D printing. Polymers. Nanostructures.