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Development of an Intraoral Device that is capable of piezoelectric activity

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Project: -

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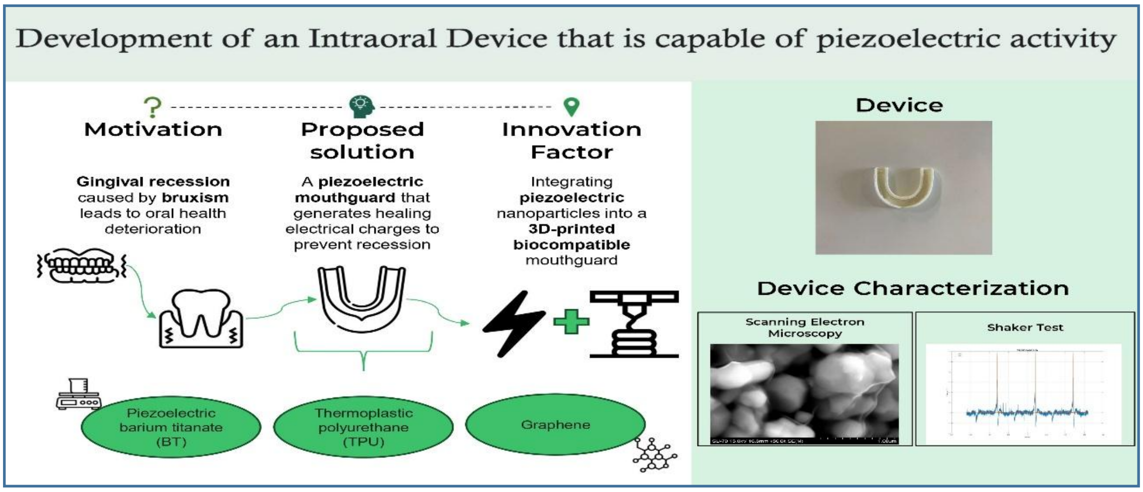
Abstract.



The utilisation of piezoelectric materials in biomedical engineering for tissue healing has increased, due to their capacity to generate electrical potential under mechanical stress [1]. The present study proposes an innovative mouthguard (MG) that employs the piezoelectric properties of materials to prevent gingival recession, a condition frequently associated with bruxism (teeth grinding).This condition can result in the exposure of tooth roots and, in severe cases, necessitate grafting [2], [3]. The MG has been developed through the utilisation of biopolymer materials, namely poly-L-lactic acid (PLLA) and thermoplastic polyurethane (TPU), in conjunction with piezoelectric barium titanate ($BaTiO_3$) nanoparticles (BTO). The selection of these combinations of materials was

made on the basis of biocompatibility, ease of processing, and piezoelectric properties. In addition, the choice of materials was made with a view to ensuring flexibility and durability when applied to the production of 3D printed mouthguards [4].

The objective of this study is to examine the potential applications of polar properties of polymer materials combined with piezoelectric nanoparticles for the development of MG. The underlying mechanism of this application is related to the role of the piezoelectric component, which facilitates the generation of electrical charges by MG and thereby enhances the process of gingival healing. For the fabrication of the proposed MG, the Additive Manufacturing process (AM), specifically the Fused Deposition Melting (FDM) method, has been selected as the production technique. In order to ascertain the morphology, structural, mechanical, electrical, electromechanical and chemical properties of fabricated MG, a number of material characterisation techniques have been employed. These include particle size distribution, rheology test and X-ray diffraction (XRD). The following analytical techniques were employed: optical microscopy, scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), contact angle measurement, atomic force microscopy (AFM), piezoresponse force microscopy (PFM), piezoelectric test (Berlincourt method) and shaker test.

Beyond material characterisation, biological validation was performed to demonstrate the feasibility of tissue growth and repair. The in vitro cytocompatibility of the samples was evaluated using human periodontal ligament cells (hPDLCs) with cell viability assays, MTT assay.

References.

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