Modification of hydroxyapatite using methacrylate compounds for potential application as fillers in resin-based composites

Dr Zuzanna Buchwald, Poznan University of Technology, Poznan, Poland
Prof. Adam Voelkel, Poznan University of Technology, Poznan, Poland

Abstract

Statement of the Problem: Secondary caries, a prevailing concern in contemporary restorative dentistry, refers to a caries ailment that arises in conjunction with the existence of restorative material within a dental cavity. One of the questions is whether the restorative material can effectively combat the disease. However, current composite fillings are inactive in this battle. Hydroxyapatite (HA) is a very perspective experimental filler for resin-based composites as it shows the remineralizing potential, understood as the ability to release calcium ions. However, certain properties of HA-based composites still require improvement, particularly the bonding between filler and organic matrix. To achieve this goal, the surface of HA was modified using methacrylate compounds via various procedures. The effects of the applied modifier type, as well as pre-impregnation, were examined.

Methods: The HA surface was impregnated and modified using HEMA (2-hydroxyethyl methacrylate), TEGDMA (triethylene glycol dimethacrylate), EGDMA (ethylene glycol dimethacrylate), MPS (3-(trimethoxysilyl)propyl methacrylate), and Bis-GMA (bisphenol A glycidyl methacrylate). The efficacy of the processes was examined using Fourier-transform infrared spectroscopy (FT-IR) and thermogravimetric analysis (TGA). A schematic diagram of the obtained fillers is presented in Fig. 1.

Conclusion & Significance: The obtained results showed that all applied modification pathways are effective. However, the process efficiency strongly depends on the applied modifier. HEMA modification was the least effective, exhibiting only slight changes in the FT-IR spectrum and the lowest mass changes in TGA experiments, while the most evident presence on the modified HA surface was observed for Bis-GMA without pre-impregnation. The next step is to prepare the composites with the obtained fillers and to check whether the conducted modifications impact the properties of the RBCs.

Acknowledgement: This work was produced with financial support from the National Science Centre, Poland (Sonata, grant number UMO-2021/43/D/ST5/00888).

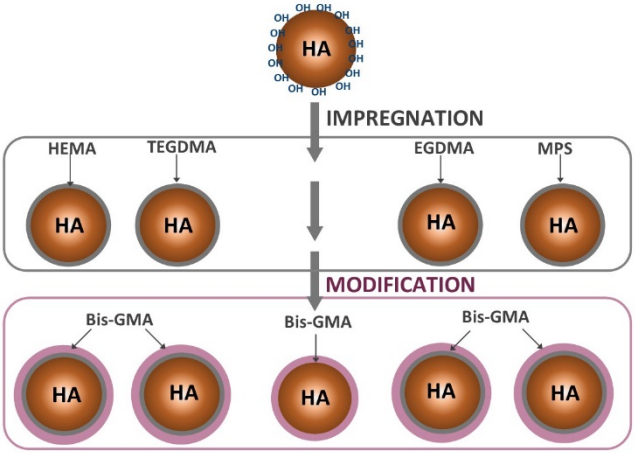
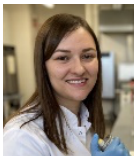


Fig. 1 Schematic diagram of the obtained hydroxyapatite fillers

Recent Publications

1. Z. Buchwald, M. Sandomierski, W. Smułek, M. Ratajczak, A. Patalas, E. Kaczorek, A. Voelkel, Physical–chemical and biological properties of novel resin-based composites for dental applications, Polymer Bulletin 80 (2023) 11249-11272.
2. Z. Buchwald, M. Szołyga, J. Zwolińska, B. Marciniec, A. Voelkel, Surface modification of hydroxyapatite with polyhedral oligomeric silsesquioxanes, Reactive and Functional Polymers 170 (2022) 105131.
3. M. Sandomierski, Z. Buchwald, T. Buchwald, A. Voelkel, Silica-filled methacrylic composites with extremely high compressive strength, Journal of the mechanical behavior of biomedical materials 116 (2021) 104319.
4. Z. Buchwald, B. Czarnecka, A. Voelkel, Inverse gas chromatography in the examination of adhesion between tooth hard tissues and restorative dental materials, Scientific Reports 10 (2020) 13476.
5. Z. Buchwald, M. Sandomierski, A. Voelkel, Calcium-Rich 13X Zeolite as a Filler with Remineralizing Potential for Dental Composites, ACS Biomaterials Science & Engineering 6 (2020) 3843-3854.

Photograph



Biography

Dr. Zuzanna Buchwald is an Assistant Professor at the Faculty of Chemical Technology of Poznan University of Technology. Since 2010, she has been dedicated to researching new dental composite materials and developing characterization methods for them. Her primary focus is on discovering novel classes of fillers with remineralizing potential to combat secondary caries. Recently, Dr. Buchwald secured funding for her project on active fillers with remineralizing potential for new dental fillings from the National Science Center, as part of the Sonata 17 call. In addition to her research on dental composite materials, she also strives to enhance the methods for examining dental materials. Dr. Buchwald has successfully utilized inverse gas chromatography (IGC) as a tool for studying tooth hard tissues and dental materials, including their adhesion properties. Her results are the first scientific description of the correlation between the IGC results and the shear bond strength test.

Email: zuzanna.buchwald@put.poznan.pl