



III Simpósio Gaúcho de Engenharia Aeroespacial e Mecânica
Santa Maria, RS, Brasil

ADVANCING ZIRCONIA DENTAL PROTHESIS MANUFACTURING WITH ULTRA-HIGH SINTERING TECHNIQUES

Abstract. Ultra-Fast High-Temperature Sintering (UHS) has emerged as a promising technique for rapidly consolidating ceramics, offering unprecedented processing speeds and energy efficiency. The UHS process provides significant advantages, such as reduced processing time, improved energy efficiency, and the potential for finer microstructure control. Therefore, it is a sintering process that enables extremely high heating rates through direct contact of samples with electrically heated thin carbon strips. This study explores the application of UHS for the sintering zirconia with 4 mol% Y_2O_3 , a unique combination of mechanical, thermal, and biological properties suitable for different applications, including dental materials. However, conventional sintering processes for zirconia often require long processing times and energy consumption. Through a parametric study, this research investigates the behavior of zirconia under UHS conditions and proposes a setup (protocol) to mitigate heat loss and improve process efficiency. The sintering protocol involved applying 30 Amperes for 30 seconds, 35 Amperes for 30 seconds, 40 Amperes for 30 seconds, 45 Amperes for 30 seconds, and 48 Amperes for 7 minutes. Subsequently, a slow cooling protocol was performed at 45 Amperes for 2 minutes, 35 Amperes for 2 minutes, and 30 Amperes for 2 minutes. Static strength and microstructure were investigated through static biaxial flexural strength tests, scanning electron microscopy, and Archimedes density measurements. The highest static strength recorded was 588.76 MPa, and the sintering protocol demonstrated the ability to produce samples with up to 98% density in just 16 minutes. The results obtained thus far suggest that the UHS technique can significantly accelerate zirconia processing. Additionally, the ability of UHS to precisely control the energy input and temperature profiles during the sintering process allows for the optimization of mechanical properties and microstructural characteristics, potentially reducing defects such as porosity and grain growth irregularities. These enhancements could lead to broader industrial applications of zirconia in sectors demanding high-performance materials, including aerospace and automotive industries, where components require materials that withstand extreme conditions.

Keywords: Sintering. Zirconia. Mechanical Behavior. Energy efficiency.