PAPER 172 – SELECTION AND PORE DISTRIBUTION ANALYSIS OF BIOCOMPOSITE IMPLANTS FOR LOAD-BEARING BONE REPLACEMENT

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ABSTRACT
Fabrication of biocomposites to promote bone growth through pore distribution and gradient formation for load-bearing bone replacement have gained attention due to their excellent mechanical properties and biocompatibility. This research study aims to investigate the selection and pore distribution analysis of homogenous, porous, and gradient biocomposite implants for load-bearing bone replacement. The study utilises powder metallurgy, scanning electron microscopy (SEM) and Image J software to produce and characterise the pore size distribution of the biocomposites, respectively. The software can segment the image to isolate the pores from the rest of the implant, measure the size of individual pores, and generate pore size distribution plots. The radar chart was adopted to compare and evaluate the mechanical strength of various biocomposite implants to identify the most suitable implant for load-bearing bone replacement. The findings of this study revealed the gradient and porous biocomposites exhibited desired mechanical properties with porosity of 20.67 and 27.72 % pore size up to 134 and 256 **µ**m, compressive strength of 162 and 95 MPa and compressive modulus of 30.42 and 28.3 GPa respectively**.** The SEM analysis, coupled with pore size distribution and porosity percentage measurements, offers valuable information for optimising the design and fabrication of biomaterials with enhanced properties. Radar chart analysis further contributes to a comprehensive evaluation of the implants' mechanical and physical characteristics.

KEYWORDS: Biocomposite, Pore, Mechanical, Properties, Selection and Image J

1. INTRODUCTION

Bone atrophy, also known as bone loss or osteoporosis, is a common condition characterised by decreased bone mass and deterioration of bone tissue. This condition often leads to weakened bones, increased fracture risk, and reduced quality of life for affected individuals (Poliakov *et al.,* 2019). In severe cases, load-bearing bones may become significantly compromised, necessitating implants for bone replacement (Bahraminasab and Farahmand, 2017). Traditional implants for load-bearing bone replacement are typically made from metallic materials such as titanium, cobalt chromium alloy or stainless steel. While these implants provide structural support, they often lack the necessary biological properties to promote bone growth and integration with the surrounding tissue (Cabezas-Villa *et al.,* 2018). Consequently, researchers and medical professionals have focused on developing biocomposite implants as an alternative solution to tailor the structural material for required mechanical and physical properties (Krishna and Suresh, 2022).

Biocomposite implants are engineered materials composed of organic and inorganic components. These materials possess a unique mechanical strength, biocompatibility, and bioactivity, making them ideal for load-bearing bone replacement and repair (Oshkour *et al.,* 2015). Biocomposite implants can provide both mechanical support and a favourable environment for new bone formation by mimicking the natural structure of bone. The selection of appropriate mechanical, physical properties and pore distribution is crucial for optimising the performance and functionality of these implants. A radar chart, a spider chart, is a graphical method utilised to select materials and process parameters in machining and manufacturing industries (Holota *et al.,* 2015; Wan *et al.,* 2013; Porter and Niksiar, 2018). This chart displays multivariate data as a two-dimensional chart of three or more quantitative variables represented on axes starting from the same point (Wan *et al.,* 2013). The relative position and angle of the axes in the radar chart provide the deviation degree of the actual value and the reference value of each index as required for the selection implant in the load-bearing application.

In selecting a load-bearing implant, biomechanical properties play a vital role in determining the implant's ability to withstand the mechanical stresses encountered during normal physiological activities. The implant's mechanical strength, stiffness, and fracture toughness must be carefully considered to ensure long-term stability and durability