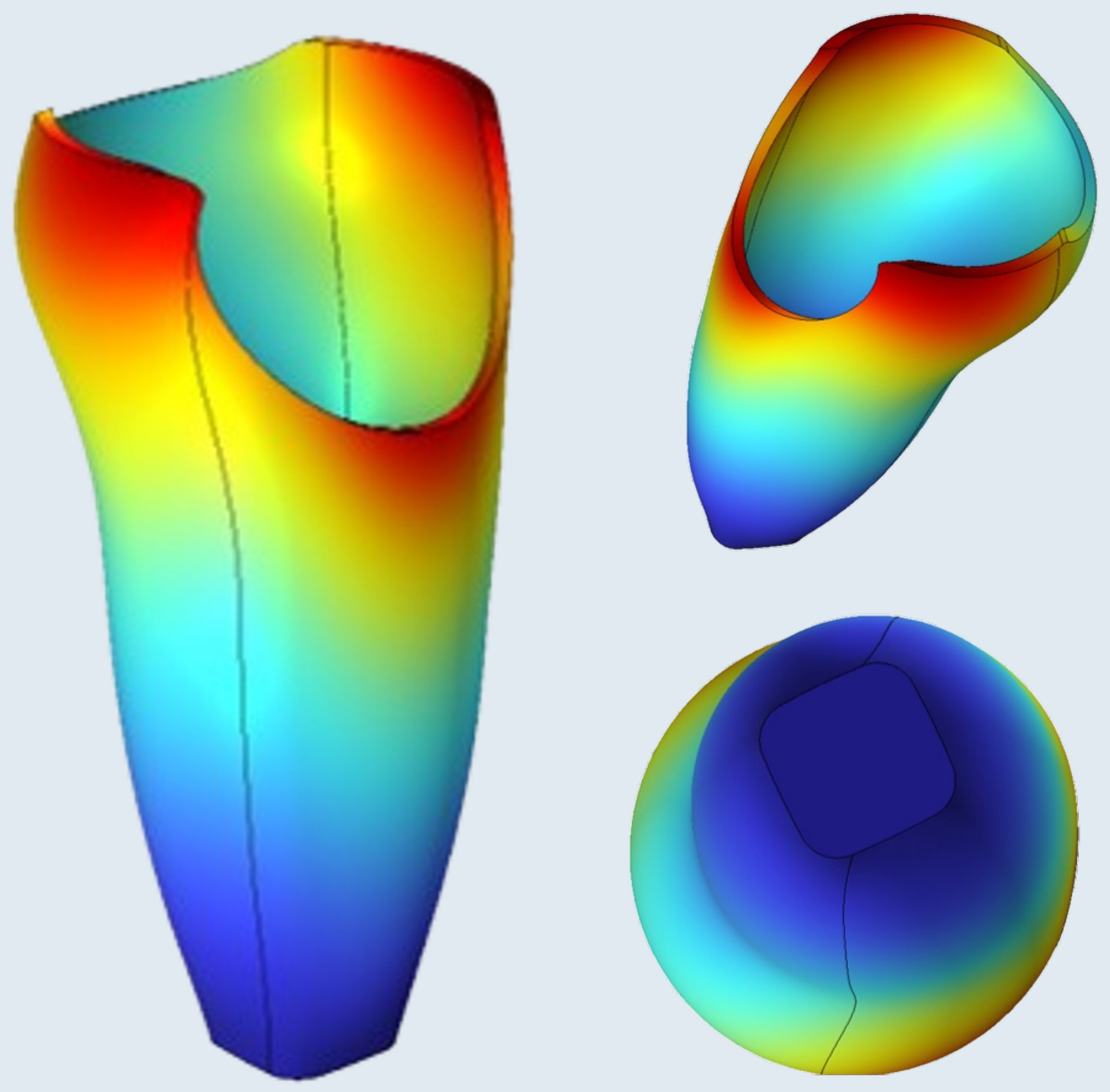

Analysis of Stress and Deformation in PALF-reinforced Prosthetic Composite

Prosthetic solutions consist of components with unique material behaviour. This work investigates one such case.

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Introduction

Globally, there is a push to promote sustainable materials and technologies that are strong, environmentally friendly, and relevant to the development of emerging societies[1]. The use of plant fibre as a reinforcing material has become popular in the polymer composite industry due to its appealing mechanical properties, the potential for biodegradability, affordability, low-energy demand for processing, and availability. Pineapple leaf fibres (PALF), which are considered agricultural waste, have shown promising properties for polymer reinforcement in previous research[2,3]. However, there has been little effort to investigate how PALF composite can be applied to prosthetic socket fabrication.

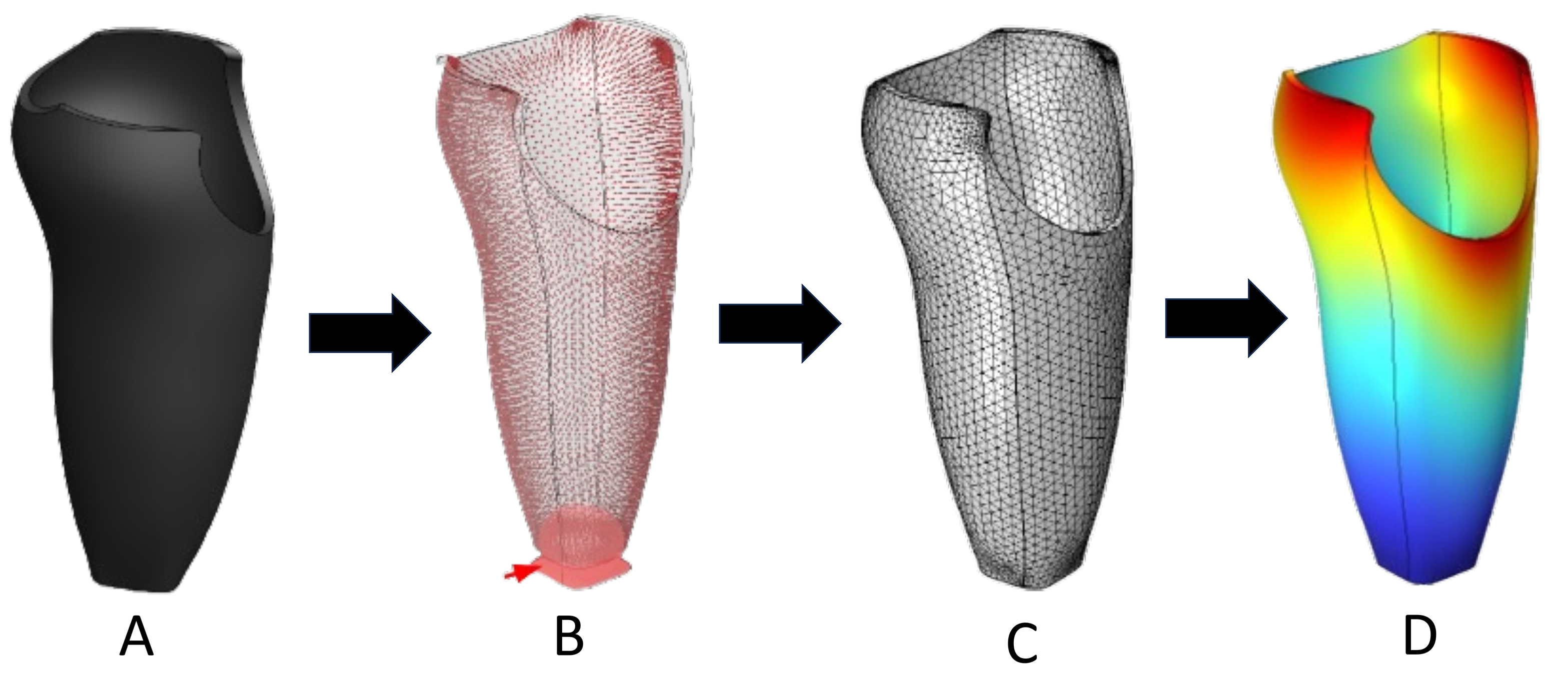

FIGURE 1. A=3D Model, B=Boundary Conditions, C=Mesh, and D=Result.

Methodology

A 3D model of a transtibial prosthetic socket (TPS) was assigned with the material properties of a new PALF composite and then subjected to static structural analysis in COMSOL Multiphysics®.

The TPS has a total surface area of 0.13 m^2 and a thickness of 4 mm, Figure 1A. The model was imported into the COMSOL® software package and boundary conditions were applied, Figure 1B. The domains were meshed using the physics-controlled mesh, and the mesh size option was set to extra fine, Figure 1C.

Results

The stress response pattern of the modeled prosthetic sockets (PS) indicates that the stress response capacities of the PS increase based on boundary conditions of internally applied socket pressure and a fixed distal end of the socket. The minimum and maximum stress responses were 12.2 MPa and 15.1 MPa, respectively, based on the PALF fibre volume. The stress in the PS resulted in the deformation behaviour shown in Figure 2. In summary, the PALF composites showed superior stress and deformation responses compared to the neat resin. The results suggest that the new PALF composite material may favour prosthetic socket applications depending on PALF volume fraction and type of resin .

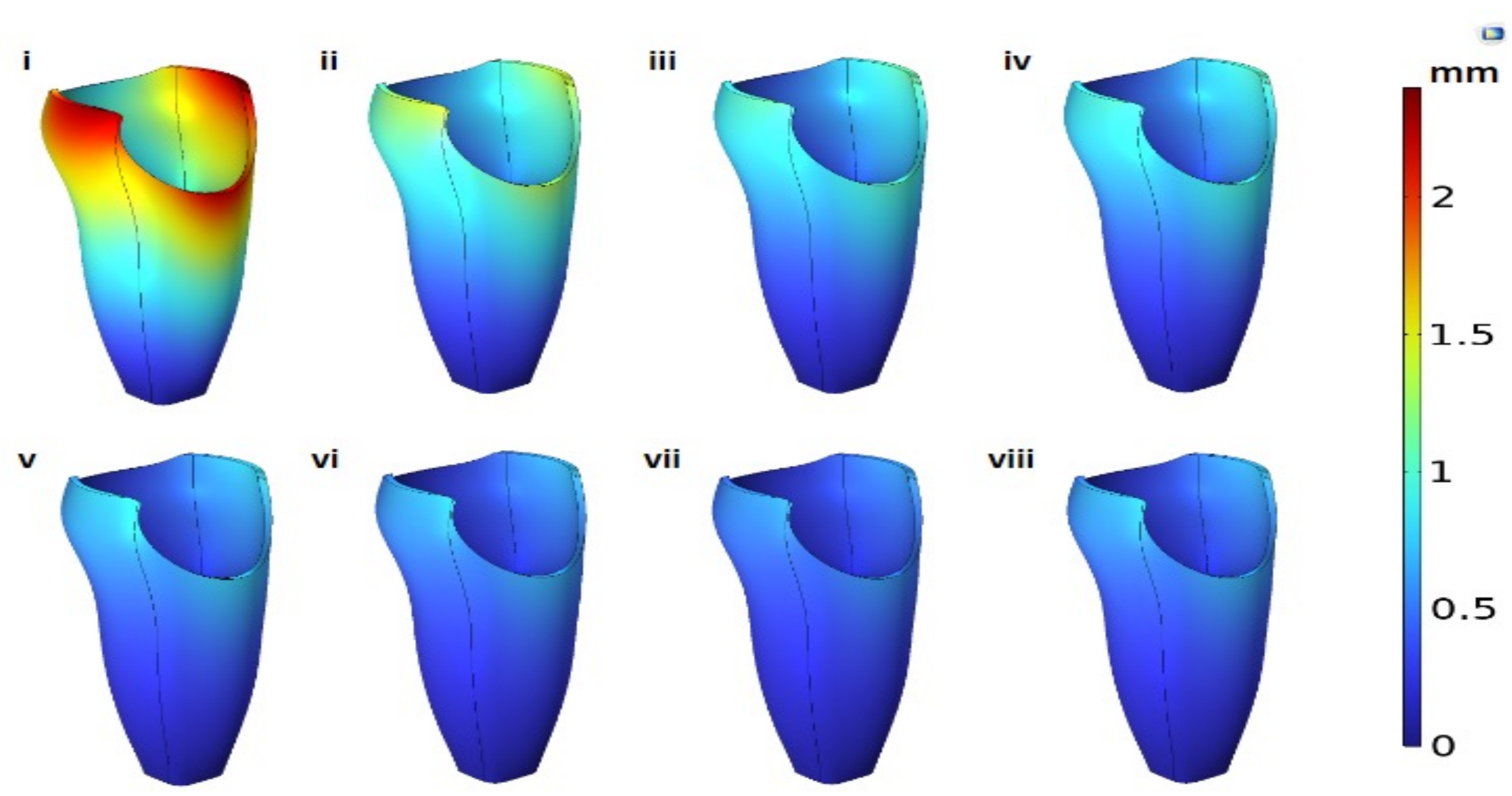

FIGURE 2. Deformation response for different PALF fiber-volume composites. i) Neat resin, ii) 5%, iii) 10%, iv) 15%, v) 20%, vi) 30%, vii) 40% and viii) 50%.

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This project is co-funded by the European Union's Horizon 2020 programme under the Marie Skłodowska-Curie Grant Agreement No. 101034352