# Dual 3D printed material mimicking mechanical behaviour of healthy and aneurysmal arterial tissue

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A phantom, 3D print from polymer material, can be of great help for applications such as medical device testing, planning of medical treatments, and for educational purposes. The phantom should not only be realistic geometry-wise, but its mechanical response should correspond to the representative mechanical behaviour as well. However, arteries are soft tissues which besides nonlinear and anisotropic behaviour can also undergo large deformations. Mimicking such a complex behaviour is not possible to achieve with a single isotropic polymer material.

As 3D printing technology builds an object by successively adding material layer by layer, the material can be defined at the voxel level. A study presented in [1] proved the feasibility of 3D printing of mechanically accurate tissue-mimicking phantoms. They indicated that dual-material phantoms can exhibit strain-stiffening behavior characteristic for soft tissues, which can never be achieved by a single polymer material. Despite demonstrating that the mechanical behavior of printed metamaterials can be tuned by changing the design parameters, they did not propose design parameters for any specific tissue.

In this study the design of metamaterial will be done by using iterative finite element (FE) simulation. The FE models of a uniaxially loaded segments will be compared with the desired stress-strain response of healthy and aneurysmal intracranial arteries [2, 3]. Orientation and arrangement of the base materials will be iteratively changed until desired behaviour is acquired. Numerically obtained design of material, layer-based combination of a different soft and stiff materials, will be 3D printed. In order to confirm realistic behaviour of chosen material in physiological range of stretches, it will be mechanically tested on a uniaxial tensile machine. Experimental stress-strain curves will be compared with the results from the FE simulations and with the experimental data reported in literature. Designed dual material will enable us to approximate a more realistic 3D printed phantom from CT arterial scans.

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