CREATING ARTIFICIAL MICROSTRUCTURE OF THE CERAMIC FOAM USING STASTISTICAL FUNCTIONS

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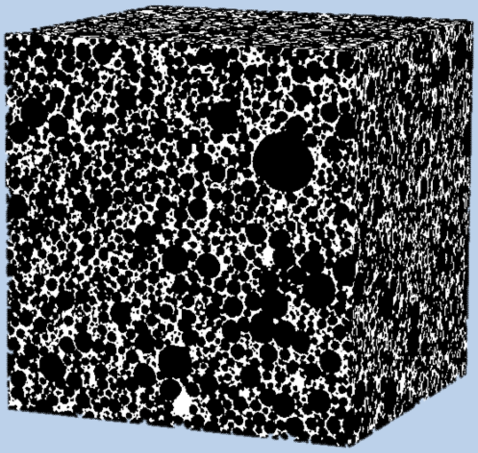

3D binary image of ceramic foam

Generating equivalent artificial microstructures

The work develops a novel microstructure reconstruction algorithm that generates 3D artificial microstructures of foam material that are statistically equivalent to the real ones. The developed microstructures also exhibit same elastic properties as the real ones.

Motivation

To study random microstructures, statistically significant number of samples are needed to draw any useful conclusions. It is impractical to manufacture this large number of samples that are equivalent to each other.

Goal

To develop a microstructure reconstruction algorithm that can generate 3D artificial microstructures of foam material that are statistically equivalent to the real microstructures. Artificial microstructure of any size can be generated provided the volume fraction and the shape and size distribution of the pores are known.

Microstructure characterization

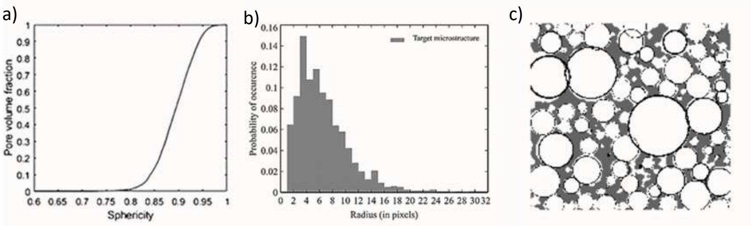

Fig. 1: a) Shape and b) size distribution of pores in the microstructure and c) a cross-section image showing approximation of pore shapes by spheres.

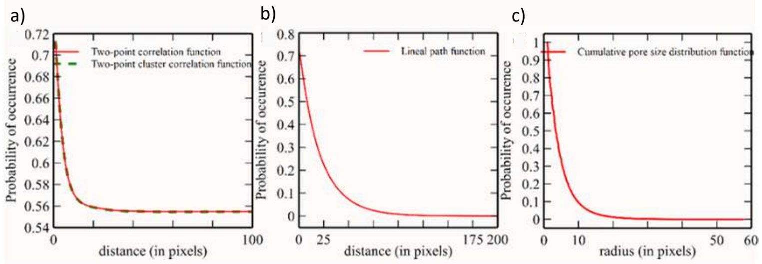

Fig. 2: a) Two-point and two-point cluster correlation functions, b) Lineal path function and c) Cumulative pore size distribution function of the real microstructure*.

* V.V. Deshpande, R. Piat, *J Europ. Cer. Sci.*, vol. 4, no. 11, pp. 5578-92, 2021.

$$\text{Energy functional, } E = \sum_{r}\sum_{\alpha}\left[f^{\alpha}(r) - \hat{f}^{\alpha}(r)\right]^2$$

Microstructure reconstruction algorithm

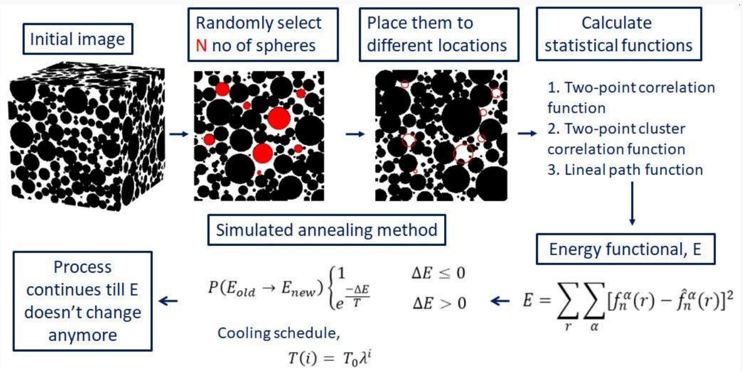

Fig. 3: Flow-chart explaining the microstructure reconstruction algorithm.

Results

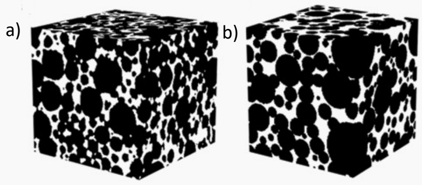

Fig. 4: a) Real and b) reconstructed microstructure.

Table. 1: Stiffness coefficients of real and reconstructed microstructure.

	C_{11}/ C_{22}/ C_{33} (GPa)	C_{44}/ C_{55}/ C_{66} (GPa)	Porosity (%)
Real microstructure	26.54	8.78	74.56
Reconstructed microstructure	26.15	8.46	74.45
Experimental measurement **	29.50	6.95	74.50

** D. Horny et at. *Adv. Eng. Mater.*, vol. 22, no. 7, p. 1901556, 2020.

Future

Multiscale modelling and microstructure optimization!

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