



**HAL**  
open science

## **Tortuosity: Local Morphology and Global Topology Combination**

Johan Chaniot, Maxime Moreaud, Loïc Sorbier, Jean-Marie Becker, Thierry Fournel, Yann Gavet

► **To cite this version:**

Johan Chaniot, Maxime Moreaud, Loïc Sorbier, Jean-Marie Becker, Thierry Fournel, et al.. Tortuosity: Local Morphology and Global Topology Combination. 14th European Congress for Stereology and Image Analysis, International Society for Stereology & Image Analysis, Sep 2025, Prague, Czech Republic. <emse-05503711>

**HAL Id: emse-05503711**

**<https://hal-emse.ccsd.cnrs.fr/emse-05503711v1>**

Submitted on 11 Feb 2026

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY 4.0 - Attribution - International License

# Tortuosity: Local Morphology and Global Topology Combination

Johan Chaniot<sup>[1]</sup>, Maxime Moreaud<sup>[2]</sup>, Loïc Sorbier<sup>[3]</sup>, Jean-Marie Becker<sup>[4]</sup>,  
Thierry Fournel<sup>[4]</sup>, Yann Gavet<sup>[1]</sup>

<sup>[1]</sup>Mines Saint-Etienne, Univ Lyon, CNRS, UMR 5307 LGF, Centre SPIN, F-42023 St-Etienne, France

<sup>[2]</sup>Manufacture Française des Pneumatiques Michelin, 23 Place des Carmes, Déchaux, 63000 Clermont-Ferrand, France

<sup>[3]</sup>IFP Energies nouvelles, Rond-point de l'échangeur de Solaize, BP 3, 69360 Solaize, France

<sup>[4]</sup>Univ. Lyon, UJM-Saint-Etienne, CNRS, Institute of Optics Graduate School, UMR 5516 LaHC, F-42023 St-Etienne, France

## Abstract

Tortuosity [1], a multifaceted concept, aims to describe the impact of a constraint, i.e., a microstructure, over some particles traveling through the porous network. The tortuosity under consideration in this study is computed by considering distances ratio [2] quantifying microstructure's morphology and topology. By leveraging the versatility of geodesic distance transform to consider gray-level images, we propose a new definition of tortuosity, named multi-constraint tortuosity. Based on this novel definition, an extension of the original *M-tortuosity* is defined, which allows the analysis of images of real materials and of binary images of porous media enhanced by local feature fields. The efficiency of our novel approach is demonstrated through its application on random schemes simulating complex microstructures [3]. These innovative and versatile solutions for pattern and microstructure analyses are made accessible through an easy-to-use plug-in in a free-access software named `plug im!`.

## References

1. Clennell, M. B., Tortuosity: a guide through the maze, Geological Society, London, Special Publications, 122(1), 299-344 (1997)
2. Chaniot, J., Moreaud, M., Sorbier, L., Marquet, P., Becker, J. M., Fournel, T., Characterizing microstructures with representative tortuosities, Science and Technology for Energy Transition, 79, 31, (2024)
3. Moreaud, M., Chaniot, J., Fournel, T., Becker, J. M., Sorbier, L., Multi-scale stochastic morphological models for 3D complex microstructures, In 2018 17th Workshop on Information Optics (WIO), 1-3, IEEE, (2018)