

# The GeoDict Virtual Material Laboratory

## Designing Integrated Software for Porous Media Characterization and Engineering

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### Abstract

The dependence of the properties of porous media on the detailed geometry is emerging as a key aspect in many current material characterization and material engineering applications. From fiber orientation and strut-thickness of sponges to effective stiffness and permeability tensors, the effect of geometry on material property is severe. The GeoDict Virtual Material Laboratory is a generic approach to integrate the characterization of existing materials and the engineering of new materials. By basing the characterization of materials on 3d images, the now omnipresent availability of  $\mu$ CT and FIB SEM images can be exploited as well as the relative ease of creating 3d images from analytic representations and surface triangulations.

Many powerful concepts are already available and mutually compatible:

- a scripting language for parameter studies and material engineering studies.
- a generic description language of analytic data, together with conversion algorithms to surface triangulations and segmented 3d images.
- integrated tools to convert statistical descriptions such as fiber diameter distribution, fiber orientation distribution and solid volume fractions into 3d images,
- integrated tools to characterize the porosity and pore morphology,
- integrated tools to characterize material function based on detailed 3d geometric models and constituent material properties
- post-processing, visualization and animation tools that enhance the understanding of porous media

The most innovative (at least fast and memory efficient) ones are the Fast-Fourier-Transform based algorithms for integral equations and partial differential equations to estimate or to compute precise bounds of permeability, effective conductivity, diffusivity and stiffness, for example the FeelMath solver technology. In contrast to traditional approaches, FeelMath predicts completely anisotropic material tensors. See [www.geodict.com](http://www.geodict.com) for more details.