SYNOPSYS®

University of Cambridge & Double Precision Consultancy Materials Analysis for Industry

Filters, Composites and Turbine Applications

"

The in-built homogenization tools have proven particularly useful for several projects and it's now quite clear that Simpleware ScanIP and its associated modules are integral to the simulation solutions that we offer to our clients, through their enhancement of our understanding of the problems we're tackling."
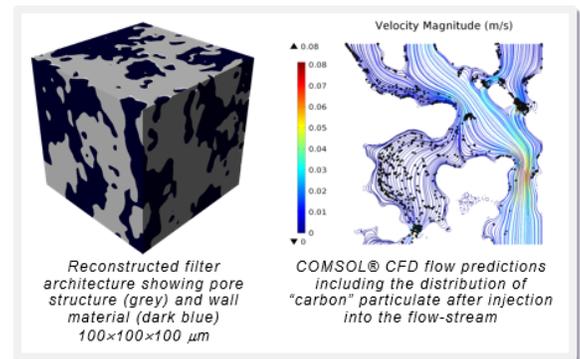
Dr James Dean
Senior Partner, Double Precision Consultancy; Senior Research Associate, University of Cambridge

DoublePrecision Consultancy

The Gordon Laboratory

Overview

Double Precision Consultancy offers services to industrial customers wanting to realistically model a wide range of physical phenomena. Dr Dean employs multiphysics simulation tools and optimization methods to help solve engineering problems, benefiting from significant experience in Finite Element Analysis and Computational Fluid Dynamics. This work builds on research at the University of Cambridge's Gordon Laboratory, studying different types of composites and coatings materials. Simpleware is a key part of their services linked to heat and mass transport through porous structures.

Highlights

- ▶ Quick reconstruction of complex materials in Simpleware software
- ▶ Built-in homogenization tools streamline materials workflows
- ▶ Multi-part meshing saves time and guarantees models for export to FE/CFD solvers
- ▶ Simulation results show excellent agreement with experimental data

Reconstructed filter architecture showing pore structure (grey) and wall material (dark blue) 100×100×100 µm

COMSOL® CFD flow predictions including the distribution of "carbon" particulate after injection into the flow-stream

Diesel Particulate Filters

Simpleware software is applied to solve the challenge of characterizing the pore architecture, tortuosity and permeability of novel diesel particle filters, with results used to optimize filtration efficiency. Simpleware ScanIP was used to reconstruct complex 3D pore structures from X-ray microCT data prior to meshing and export to COMSOL Multiphysics®. The passage of gas and diesel particulate through the structure was simulated, and results are being used to help optimize microstructure to improve filtration efficiency (alongside improvements to thermal shock resistance).
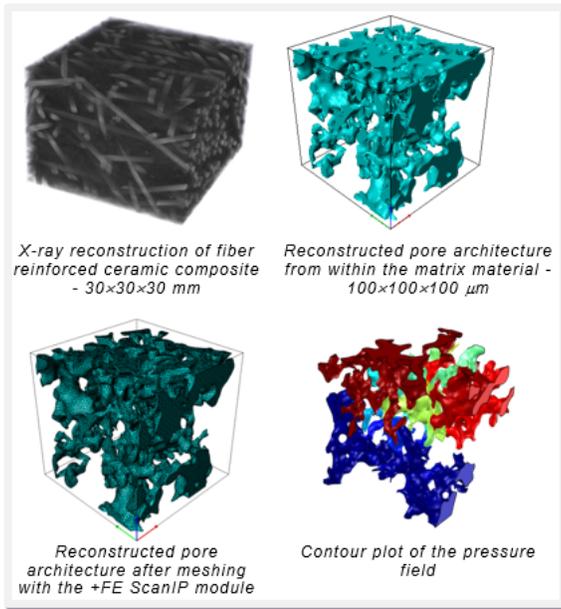
Characterizing Composites

Simpleware software is used to help characterize the pore architecture, pore volume, pore surface area and specific permeability of metal fiber reinforced ceramic matrix composites. These materials are currently employed in a range of demanding industrial applications where high temperature strength and creep resistance are essential. See below for an example of segmentation of the pore structure from a matrix material using Simpleware ScanIP, meshing in Simpleware FE and permeability calculations in the Simpleware FLOW module. Predicted values were in excellent agreement with experimental results.

X-ray reconstruction of fiber reinforced ceramic composite - 30×30×30 mm

Reconstructed pore architecture from within the matrix material - 100×100×100 μm

Reconstructed pore architecture after meshing with the +FE ScanIP module

Contour plot of the pressure field

Volcanic Ash and Gas Turbines

Ongoing research is being carried out into the deposition of volcanic ash in gas turbine aero-engines, particularly in terms of characterizing the parameters (material or otherwise) promoting the adhesion of volcanic ash. This work focuses on characterizing the thermal softening point (T_g) of amorphous phases within volcanic ash particles, and prediction of the particle temperatures during their transit through the engine. Simpleware ScanIP is used to reconstruct and mesh 3D particle geometries for simulation of heat transfer in ABAQUS.

Reconstructed ash particle (~25 μm)

Predicted contours of heat flux
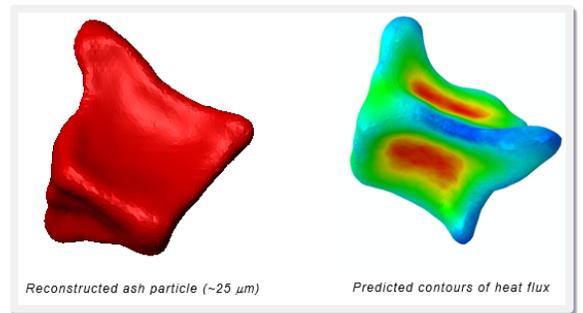
The reconstructed ash particles are also used to model their response to high speed impact at elevated temperatures, for example within an aero-engine. Data from the project is being used to better understand the mechanisms and likelihood of ash deposition and conditions for favorable adhesion. Strong industrial interest in this work has come from companies such as Rolls Royce and EasyJet, through projects like Provida - http://www.ccg.msm.cam.ac.uk/initiatives/provida

SYNOPSYS®
Predictable Success

Simpleware Product Group, Synopsys (N.E.) Ltd., Bradninch Hall, Castle Street, Exeter, UK, www.simpleware.com