FRAUNHOFER Institute for Industrial Mathematics, ITWM

Mathematics is a Technology

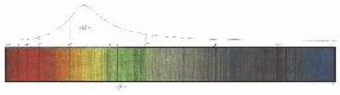
Fraunhofer ITWM

Joseph von Fraunhofer (1787 - 1826)

Researcher
discovery of "Fraunhofer Lines" in the sun spectrum

Inventor
new methods of lens processing

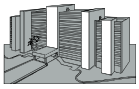
Entrepreneur
head of royal glass factory



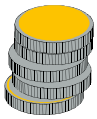
Fraunhofer ITWM

Fraunhofer-Gesellschaft Profile 2011

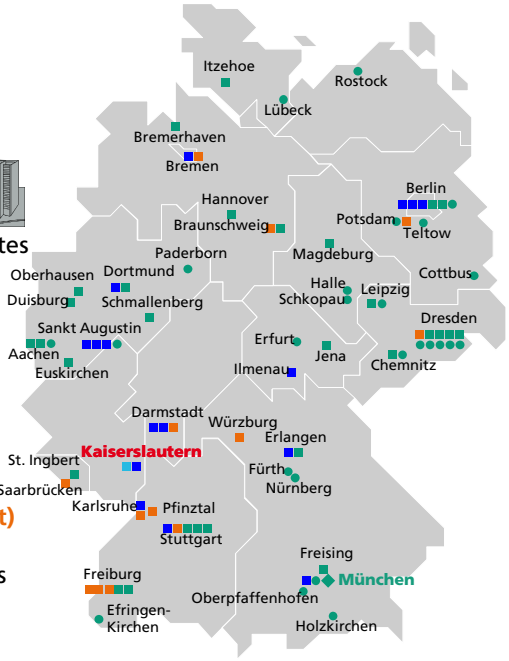
18 000 employees



60 institutes



1.65 billion € budget



7 alliances

- Microelectronics
- Production
- **Information and Communication**
- **Materials and Components (guest)**
- Life Sciences
- Surface Technology and Photonics
- Defense and Security Research

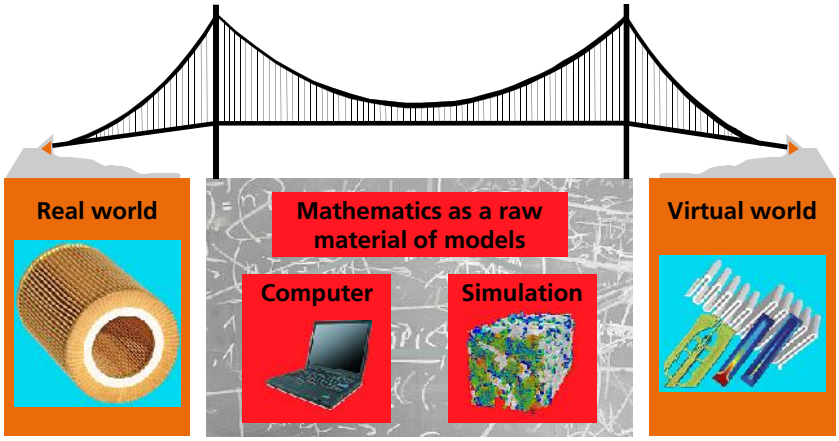
Fraunhofer ITWM – Mathematics is a key technology

- Founded in November 1995
- Fraunhofer Institute since 2001 (the first one with focus on mathematics)
- Departments
  - Transport Processes
  - Flow and Material Simulation
  - Image Processing
  - System Analysis, Prognosis and Control
  - Mathematical Methods for Dynamics and Durability
  - Optimization
  - Financial Mathematics
  - Competence Center »High Performance Computing«
- 220 employees as well as around 160 research assistants
- Total budget in 2010: appr. 16.3 Mio Euro
- largest institute for industrial mathematics worldwide

Fraunhofer ITWM

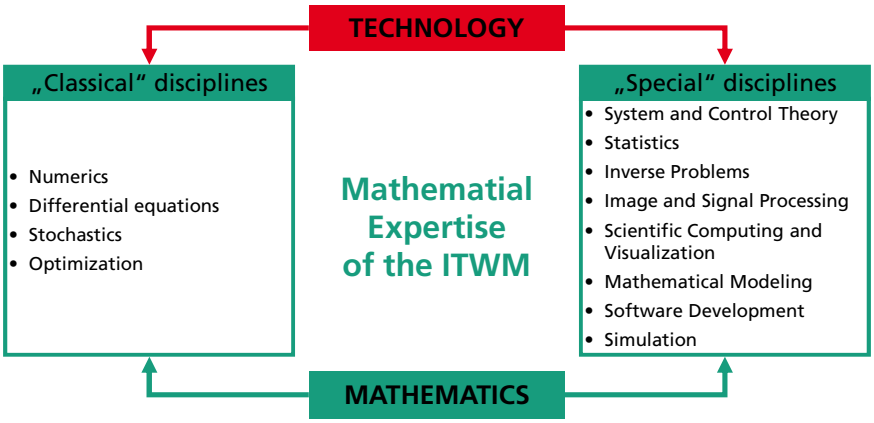
Mathematics is a Key Technology

Data Analysis – Modeling – Programing –
Simulation – Optimization – Visualization



Fraunhofer ITWM

Mathematical Core Competences of the ITWM



Fraunhofer ITWM

Departments – Business Areas

- Transport Processes
- Flow and Material Simulation
- Image Processing
- System Analysis, Prognosis and Control
- Mathematical Methods in Dynamics and Durability
- Optimization
- Financial Mathematics
- Competence Center High Performance Computing and Visualization

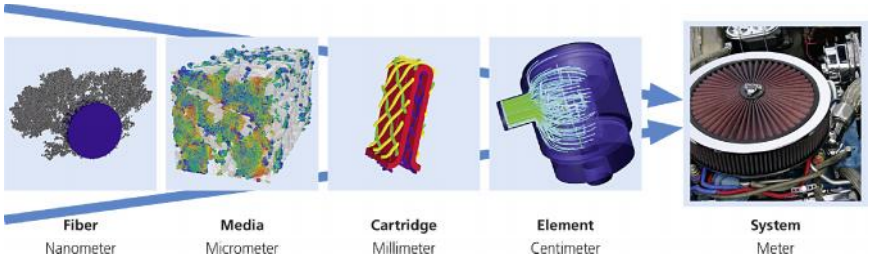
Fraunhofer ITWM

Fraunhofer System Research for Electromobility FSEM

- Förderung: Bundesministerium für Bildung und Foschung (Konjunkturpaket II)
- Budget: 30 Mio € + 14 Mio € für Investitionen aus dem Konjunkturpaket I
- Projektleitung: Prof. Dr. U. Buller (Vorstand Forschungsplanung der FhG)
- Projektkoordinator: Prof. Dr.-Ing. H. Hanselka (Direktor Fraunhofer LBF)
- Dauer: bis Juni 2011

Stromerzeugung → Energietransport und -verteilung → Schnittstelle: Stromnetz ⇔ Auto → Energiespeicherung Neue Fahrzeugkonzepte → Recycling

FLOW AND MATERIAL SIMULATION



Fraunhofer ITWM

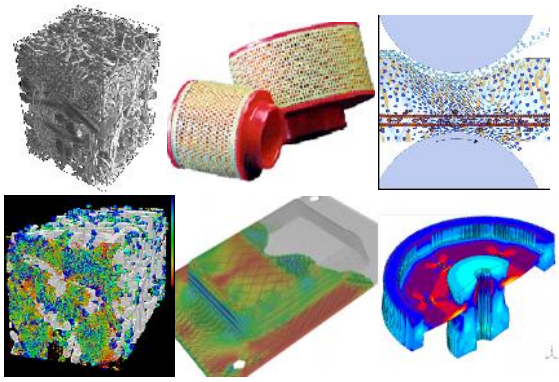
Flow and Material Simulation

Groups:

- Hydrodynamics and CFD
- Complex Fluids
- Micro-structure simulation and virtual material design
- Mechanics of Materials

Research:

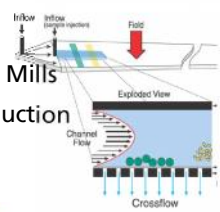
- Efficient numerics for large complex systems
- Multi-scale simulation



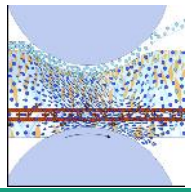
Fraunhofer ITWM

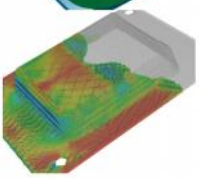
Application areas

- Porous material design (tech. Tex., Paper,…)
- Composite material design (CFK, GFK, MMC)
- Filtration (media design, filter housing)
- Separation of suspensions, fractionation
- Injection moulding (PIM, RTM, concrete)
- Granular material processing: Silo, Mixer, Mills
- Paper or gypsum-fiber-plasterboard production
- Fuel cell and battery performance

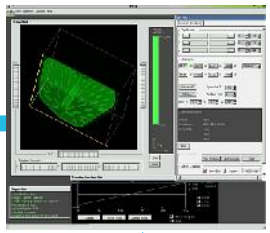






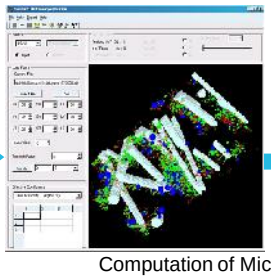
Virtual Material Design Cycle – Multi-scale simulation

Property Requirements Fulfilled?



Virtual Design Cycle

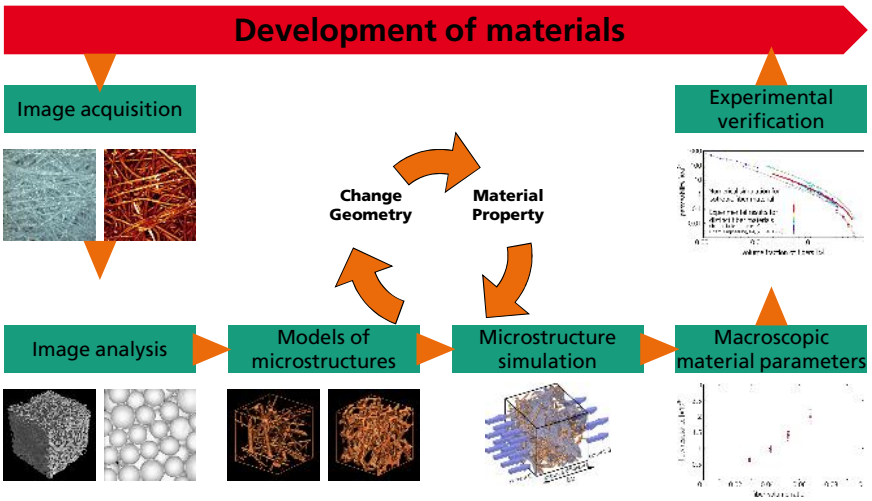
Selection of Media Types, Dimensions, etc.



Computation of Macroscopic Properties of the Filter

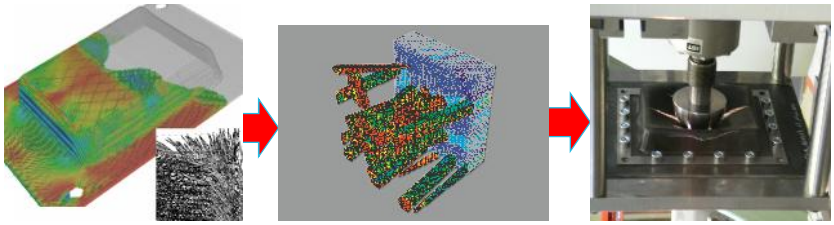
Computation of Microscopic Properties of the Filter Medium

Virtual material design



Process Chain: Production – Material – Product (Functionality)

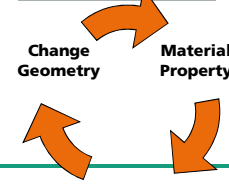
Light weight design



Production process
• injection moulding

Material simulation
• reinforced plastic

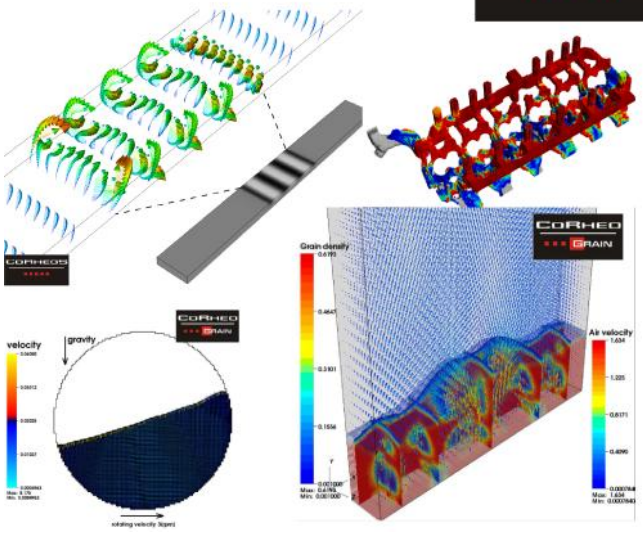
Computer Aided Engineering
• Crash, creep, …



Fraunhofer ITWM

CoRheoS: Complex Rheology Solvers

Software platform to model and simulate suspensions flows and compaction



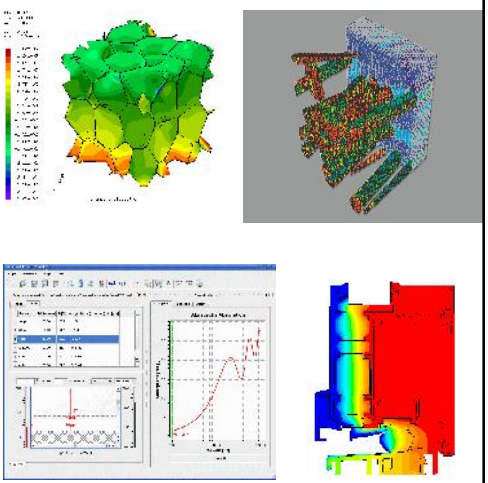
- Granular flow
- Injection molding
- Particle of Fiber concentration
- Micro fluidic of suspensions
- Multi-physics

Fraunhofer ITWM

Mechanics of materials

FeelMath

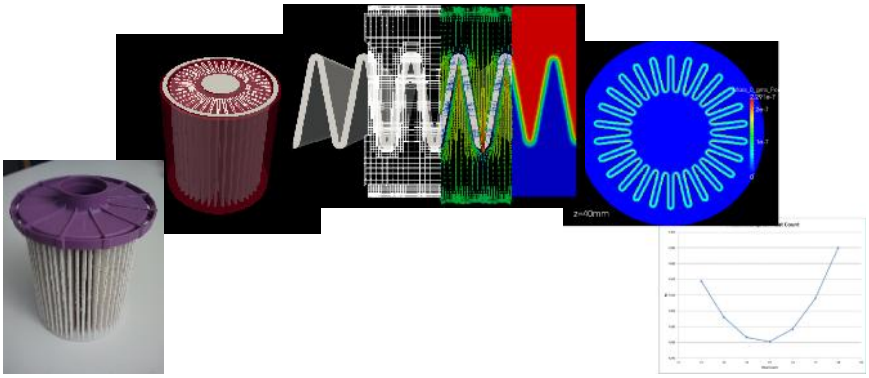
- Micro mechanics of visco-elastic-plastic composites
  - particle/fibre reinforced materials
  - foams
  - paper, non-wovens
- FeelMath: Finite Elements for Elastic Materials and Homogenization
  - robust meshing TopMesh
  - fast solver & FE²
- Structure optimization
  - door material and construction
  - knee prosthesis, tooth implant
  - optimal fibre placement in composite
- Acoustics
  - porous absorber
  - design tool: AdOpt



Fraunhofer ITWM

FiltEST

The Filter **E**lement **S**imulation **T**oolbox



Fraunhofer ITWM