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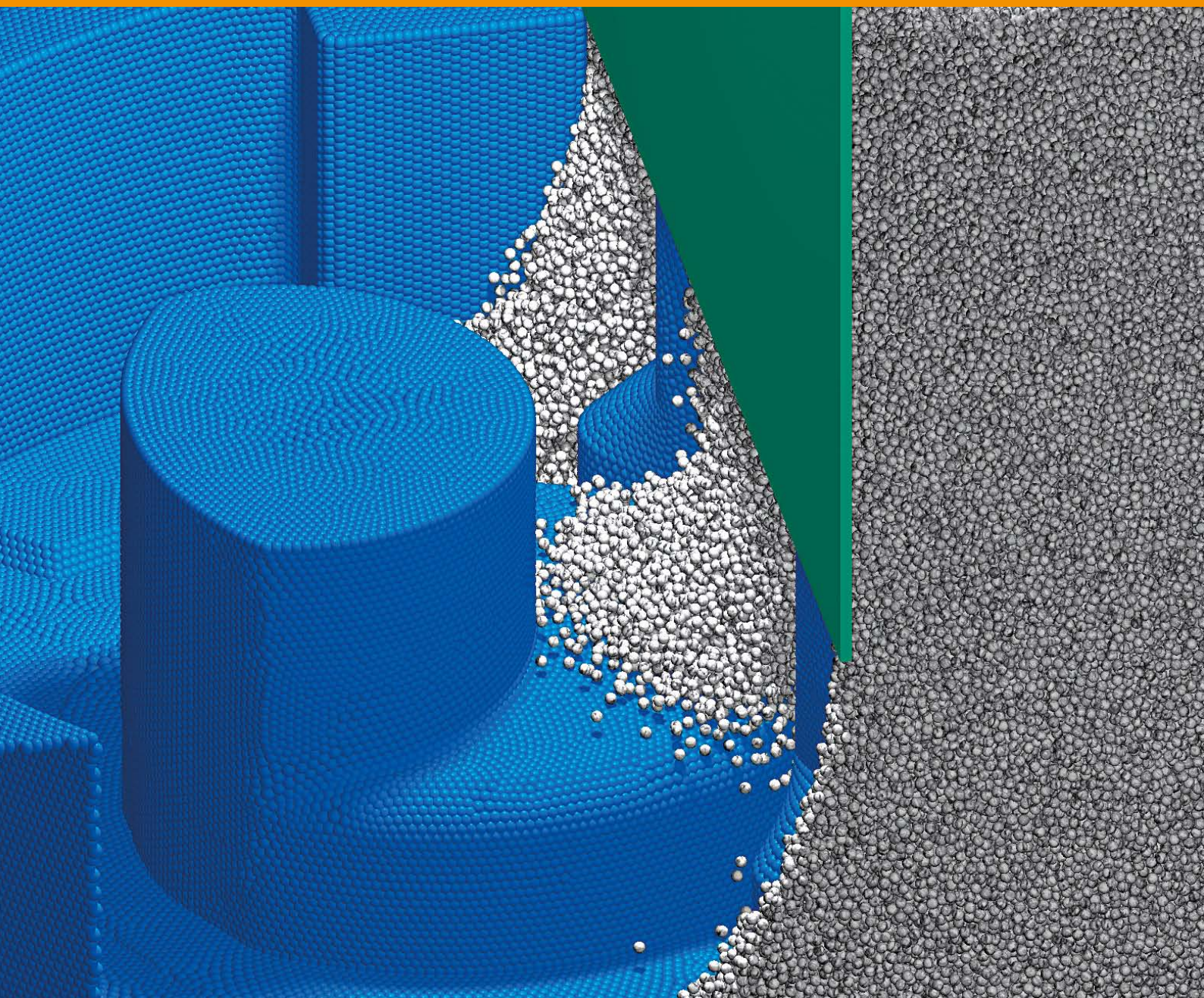
FRAUNHOFER INSTITUTE FOR MECHANICS OF MATERIALS IWM

SimPARTIX®

PARTICLE-BASED SIMULATIONS OF FLUIDS AND GRANULAR MATERIALS



UNDERSTANDING AND OPTIMIZING DYNAMIC PROCESSES

SimPARTIX® is an innovative and powerful simulation tool based on particles for modeling the dynamics of granular materials and complex fluids and has been developed at the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg. Based on sound physical models, the software can be used to investigate the behavior of various classes of materials in a wide variety of applications.

The fundamental principle of SimPARTIX® is simple: the material to be simulated is always represented in the computer in the form of individual particles. In the case of a powder, for example, every individual grain is considered separately, which results in a far more realistic modeling of the powder's behavior than is the case with simulation based on conventional, continuum mechanics approaches. The interactions between the particles are described on the basis of the discrete element method (DEM), using appropriate physical force laws.

SimPARTIX® also uses this approach to model the behavior of (complex) fluids. In this case, the individual particles can be regarded as »lumps of fluid«. Smoothed particle hydrodynamics (SPH) forms the basis of the physically correct analysis of the interactions between the particles of the fluid. The resulting, straightforward consideration of free surfaces, transport processes and complex rheology are the key advantages of the SPH method compared to traditional, mesh-based computational fluid dynamics (CFD) methods.

Typical applications for SimPARTIX® are powder technology production processes, the flow behavior of suspensions and pastes as well as the dynamics of bulk materials. Partners from industry or science use the simulation suite in collaboration with the Fraunhofer IWM in order to thoroughly optimize their processes and materials. This increases process efficiency and reduces costs.

Services

Process simulation

SimPARTIX® simulations help us to help you carry out specific optimization measures. In doing so, you benefit from our many years of experience in the field of numerical simulation of granular materials and complex fluids.

Process visualization

SimPARTIX® simulations provide you with a detailed insight into the material under investigation throughout the entire process. Accurate visualization makes relationships between process parameters and resulting properties clearly identifiable.

Process optimization in the fields of

- Powder technology (spray drying, die filling, compaction, sintering)
- Shaping (tape casting, extrusion)
- Printing processes (screen and stencil printing)
- Separation processes (wire sawing)
- Magnetorheology (automotive clutches)

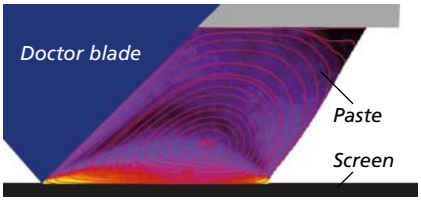
Modeling of the material behavior of

- Powder, bulk material, granular media
- Pastes, slurries, suspensions, gels

CASE STUDIES

SCREEN PRINTING

Simulations of the screen printing of circuit boards give us information about the flow and peeling behavior of the paste. SimPARTIX® is used to model different pastes and to identify the properties which guarantee the optimum printed image, helping to avoid expensive trial-and-error studies.



Flow behavior of a noble metal paste during the printing process (color coding: shear rate).

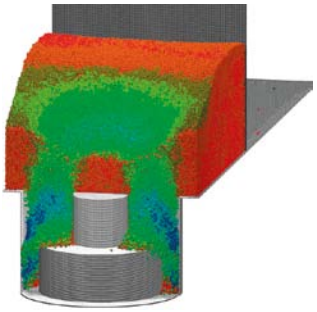
TAPE CASTING

Simulations of ceramic tape casting at the Fraunhofer IWM are used to analyze the influence of several material and process parameters on tape properties. This analysis covers the macroscopic flow behavior as well as the structure at the microscopic level.

Microscopic representative volume cell of a casting slurry (only solid particles are illustrated).

DIE FILLING

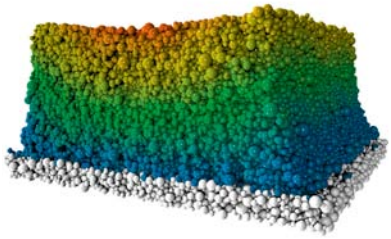
SimPARTIX® simulates the density distribution during die filling at particle level. This allows for computational process optimization with the aim of achieving a homogeneous bulk density. The homogeneous filling of the die prior to compaction is an important requirement for maintaining the dimensional accuracy of the final part.



Visualization of the powder flow during die filling (color coding: particle velocity).

SINTERING

Due to its particle-based approach, the software suite naturally takes effects such as particle rearrangement or an anisotropic microstructure into account. SimPARTIX® is used to detect critical conditions that facilitate crack formation in order to take measures to avoid them in future.



Thin ceramic film sintered on a rigid substrate (white) (color coding: strain in axial direction).

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The Fraunhofer Institute for Mechanics of Materials IWM characterizes, simulates and evaluates the behavior of materials in components and systems during their manufacture and service. The aim is to improve component and system safety, reliability, life time and functionality as well as process cost-effectiveness.

At the Fraunhofer IWM, we approach all thematic issues first and foremost in terms of the material and in terms of how the material properties and the component behavior change as a result of the mechanical, thermal, chemical or electrical loads associated with a technology or an application. To master these challenges, the Fraunhofer IWM draws on its core competencies in material and component characterization, material modeling and simulation, and interface and surface technology.

The Simulation tool SimPARTIX® is developed and supported by the scientists at the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg in South-West Germany.

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe.

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The management system at the Fraunhofer IWM is certified according to ISO 9001:2000.