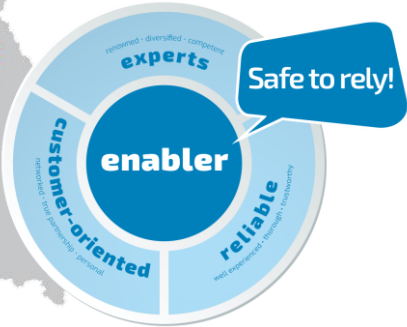


Injection moulding in the SKZ

- Industrial Service -

Dipl.-Ing. (FH) Christian Deubel
11-2023



The enabler – for the plastics industry



Founded 1961 in Würzburg

More than 430 employees

More than 400 members in the network

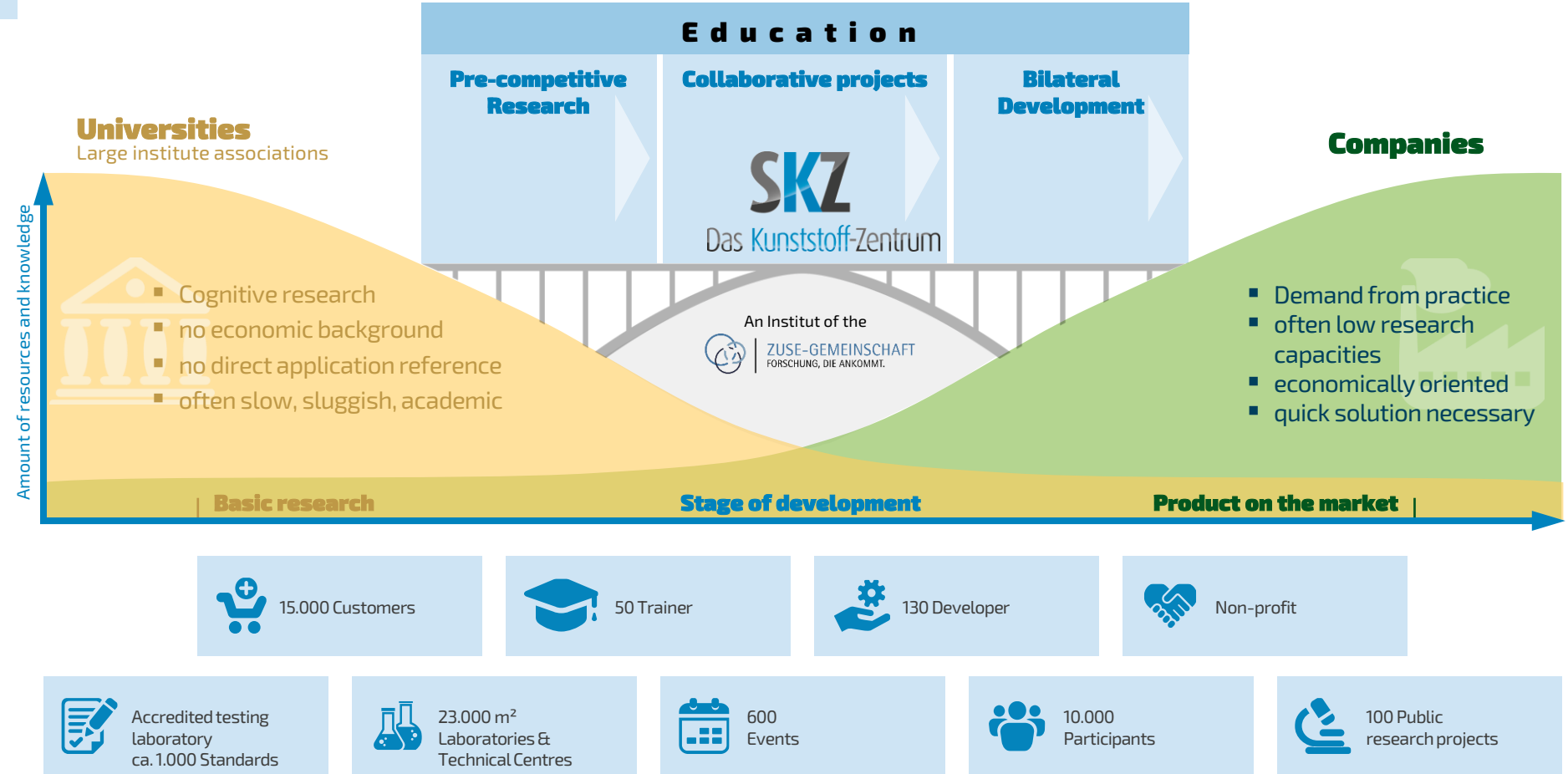
Member of the AiF and the Zuse Association

Accredited for testing, monitoring and certification



The enabler

for the plastic industry



Overview

of the business fields



More than 400 members in the FSKZ network | Events with more than 10.000 participants annually

NETWORKING

Product monitoring
Product certification
Product testing
Expert opinions
Damage analysis

TESTING



Product analysis
Process measuring technology
Damage analysis
Polymer characterisation

ANALYTIK SERVICE OBERNURG



Practical training
Workshops
Courses
In-house training
Training for masters and technicians
Studies
Online-courses

TRAINING



Materials
Processing
Material development
Compounding
Extrusion
Injection Moulding
Additive Manufacturing
Inspection and test methods
Sustainability
Circular Economy
Lightweight construction
Digitization

RESEARCH



ISO 9001
ISO 14001
ISO 45001
ISO 50001
IATF 16949
ISO 22000
ISO 13485
SpaEfV
FW 605

CERTIFICATION



Material development

- Material/Additive Searches
- Formulation development
- Specifications, ...



Compounding & Compounding Processes

- Modification of thermoplastics, incorporation of additives ..
- Manufacture of customer-specific materials



Processing

- Extrusion (Profiles, tubes, foils)
- *Injection moulding*
 - *Manufacture of test specimens*
 - *Manufacture of components*
 - *Material/mould sampling*
 - *Simulations*
- ...
- Joining (therm. joining, US welding, gluing)
- Thermoforming
- Blow moulding
- 3D Printing (Thermoplastics & Resins)

Surfaces

- Surface pre-treatment/activation (Plasma, Corona, VUV ...)
- Surface Characterization

Testing's & Analyses

- Mechanical tests (static, dynamic)
- Creep tests
- Thermal analysis
- Spectroscopic analyses
- Chemical analyses
- Weathering/Storage Tests
- Microscopy, SEM and CT measurements
- ...

Other Areas

- Sustainability & Circular Economy
- Digitisation
- Non-destructive testing
- Reactive Systems / Crosslinking Materials
- Dispersion process, resin development
- Micro/nanosuspensions

Injection Moulding

at a glance



Over 130 industrial orders per year

More than 150 courses

20 - ongoing research projects

Research, Industrial Services & Education

More than 10 injection moulding machines with clamping force of 500 – 5,000 kN

Multi-component injection moulding

Thermoplastic Foam Injection Moulding

ARBURG FDC , Processing of long fibres

Processing of thermosets

Processing of LSR

Industry 4.0 Injection Moulding Cell

Colouring with Masterbatch and Liquid Colours

Injection molding

Adhesion of hard/hard and hard/soft composites (TPE, VDI2019)

Fiber Length Distribution (SKZ- "FiVer")

Determination of fiber fractions and orientations

Inline thermography for 100% component inspection (SKZ "TDI")

DOE: Statistical Design of Experiments (SKZ- "MESOS")

Testing & Analysis

Practical courses

Workshops

Courses

In-house training

Master craftsman and technician training

Online training

Creation and provision of WBT's

Individual training and further education concepts

EDUCATION

Production of standard and individual test specimens

Simulation of injection moulding processes (Moldex3D, SIGMASOFT)

Material and mould sampling

Processing of PVC and high-temperature thermoplastics

Customer-specific material/mould tests

On-site (process) consulting

Feasibility studies

Industrial Services

Publicly funded projects (e.g. ZIM, IGF, BMBF ...)

Bilateral R&D projects
Research

Industry Consortium Projects (SKZ Trailblazer)

Research

Industrial Service

Industrial Service:

Standard Test Specimens

Our capabilities

- Injection moulding of standard test specimens
- Miscellaneous tension rods, impact rods, incendiary/LOI rods
- Plates for shrinkage measurement, puncture tests, electrical tests, ...
- Test specimens for welding/bonding tests
- ...



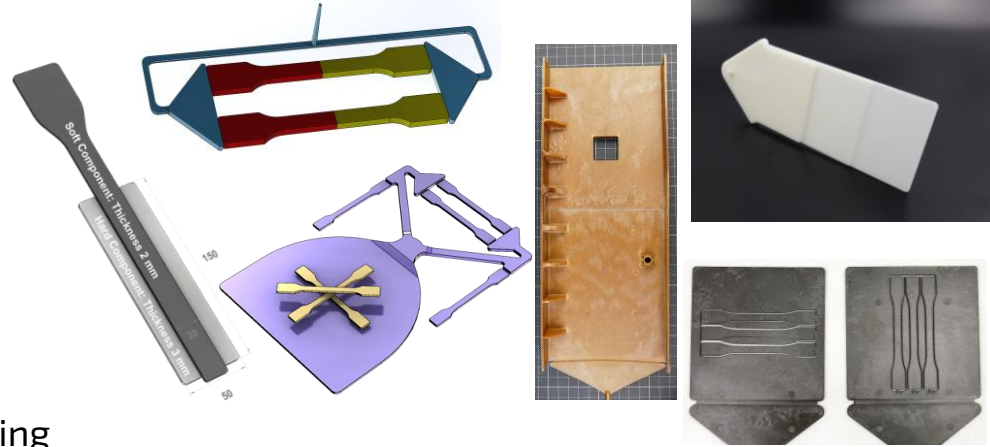
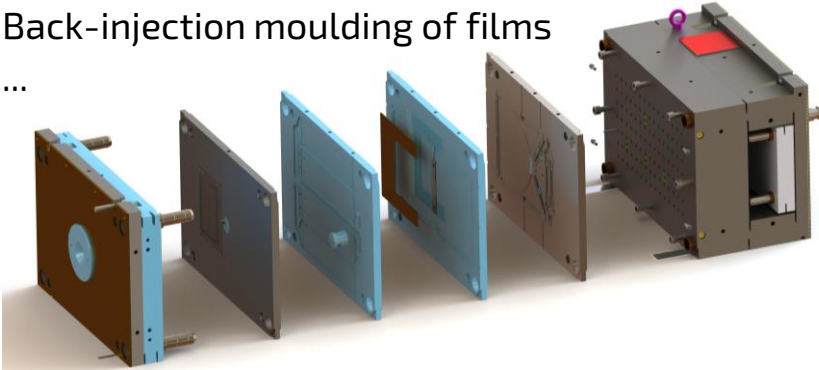
Our offer

- We manufacture your test specimens with qualified specialists
- The component is always a material-specific pre-drying, a moisture measurement and an injection moulding protocol
- In addition, almost all relevant tests and analyses can be carried out in our accredited laboratory at the SKZ

Industrial Service: Special Test Specimens

Our capabilities

- Injection moulding of *special test specimens*
- Plates up to 310x310 mm
- Plates up to a length of 450 mm
- Special Test Specimens for Fiber-Reinforced Thermoplastics
- *Adhesion Test Specimens* (Hard/Hard & Hard/Soft)
- Step plates with different surfaces for colouring tests
- Test specimens for foamed thermoplastics
- Back-injection moulding of films
- ...



Our offer

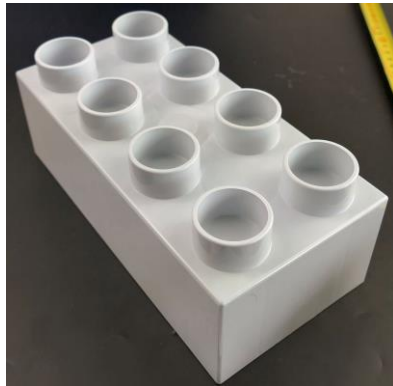
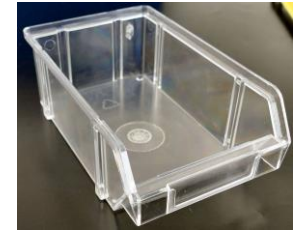
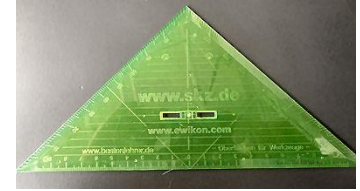
- The production of *individual, customer-specific test specimens* is possible in conjunction with our universal master forms
- Dimensions, thickness, surface quality and, for example, connection can be adapted
- We can produce individual geometries for you from larger formats by means of sawing, milling or water jetting

Industrial Service:

Injection moulding of components

Our capabilities

- *Many* injection moulds with components are available at the SKZ
- We use them as part of our practical courses and for the sampling of thermoplastics in customer trials
- In addition to hot and cold runner moulds, moulds with multiple cavities are also available



Our offer

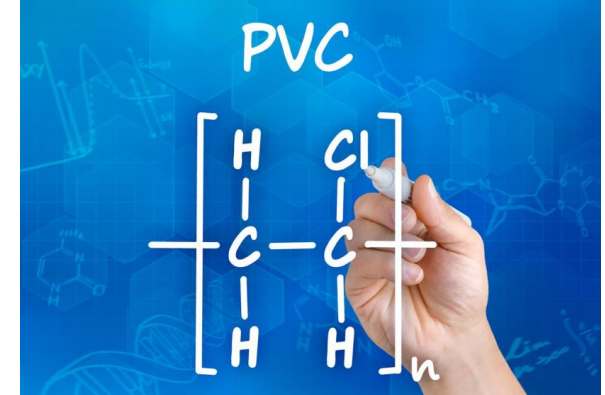
- Sampling of thermoplastics regarding processability, demoulding behaviour, flow behaviour, cycle time, shrinkage & distortion, etc. with customer materials
- Production of sample parts for newly developed materials
- We are happy to lend our moulds to partners for customer or trainee events for a small fee

Industrial Service:

Processing of PVC

Our capabilities

- The SKZ is one of the few facilities that also processes PVC
- Appropriate PVC screws and/or aggregates are available for this purpose
- In addition, it is possible to have dry blends produced directly at the SKZ



Our offer

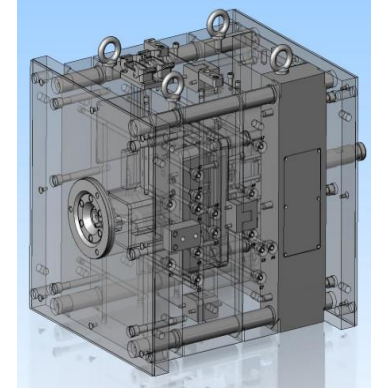
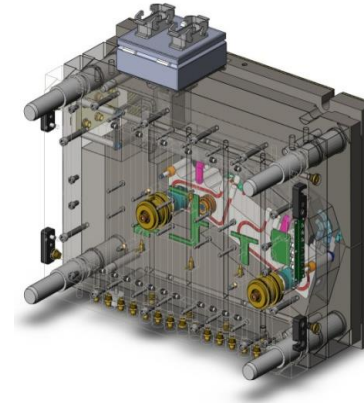
- Processing of PVC into test specimens
- Collaboration with our material development department to optimise/modify and/or develop new PVC grades
- Processing of PVC in compounding and extrusion

Industrial Service:

Material- and mould sampling

Our capabilities

- Injection moulding machines with clamping forces of 500 to 5,000 kN are available at the SKZ
- Mixing nozzles, special screws and interchangeable units are available for some machines
- Almost all our machines are comprehensively equipped with interfaces/special options
- In addition, modern peripherals are available



Our offer

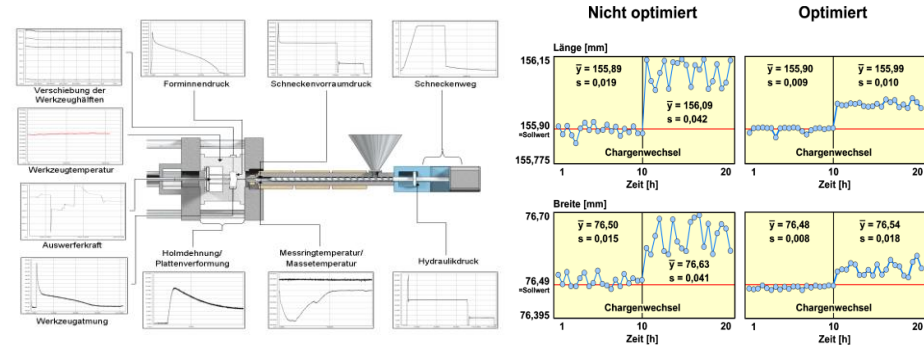
- Sampling of new materials
- Comparative sampling of different thermoplastics
- Sampling of new moulds or customer serial moulds
- Use of measurement technology to assess processing behaviour
(e.g. demoulding force, inline thermography for determining the demoulding temperature, inline colour measurement, cavity pressure ...)

Industrial Service:

Process optimisation/on-site consulting

Our capabilities

- Our team of trainers and technical centre employees consists of experienced master craftsmen and technicians
- Thanks to the close links with our research and development, we also have access to the latest findings from research projects and experts
- In addition to imparting knowledge in our injection moulding courses, we are also happy to be available on site

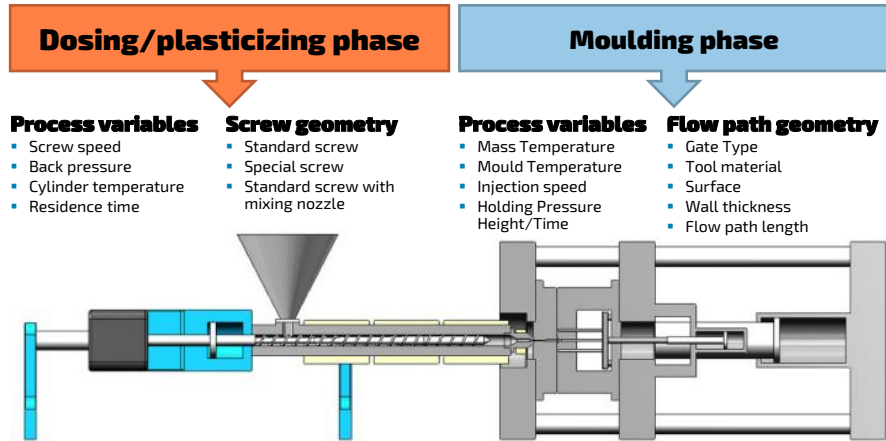
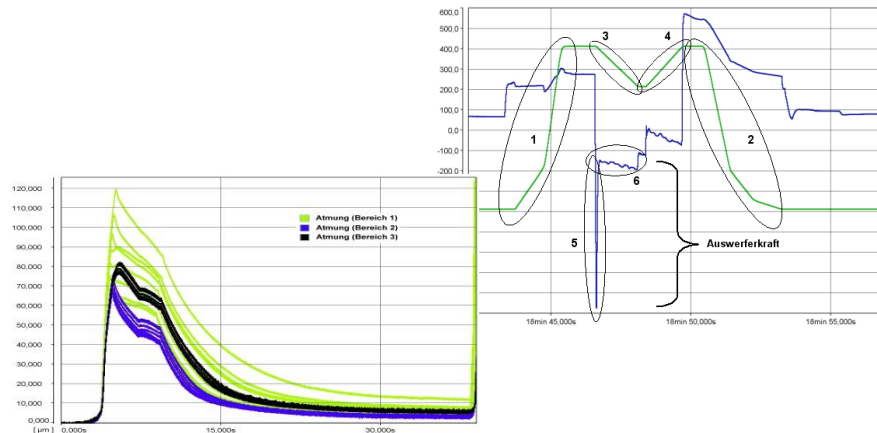


Our offer

- Unbiased view of the injection moulding process and the mould
- On-site support for process analysis/optimization and troubleshooting
- Test documentation and report of the findings
- Furthermore, a process analysis on the customer's mould is possible in the technical centre of the SKZ

Our capabilities

- The comprehensive and state-of-the-art equipment in our technical centre is available for *customer trials*
- Injection moulding machines, temperature control and dosing technology, measuring and analysis equipment can be flexibly integrated and combined according to requirements
- Our universal basic-mould setup can usually be modified with little effort



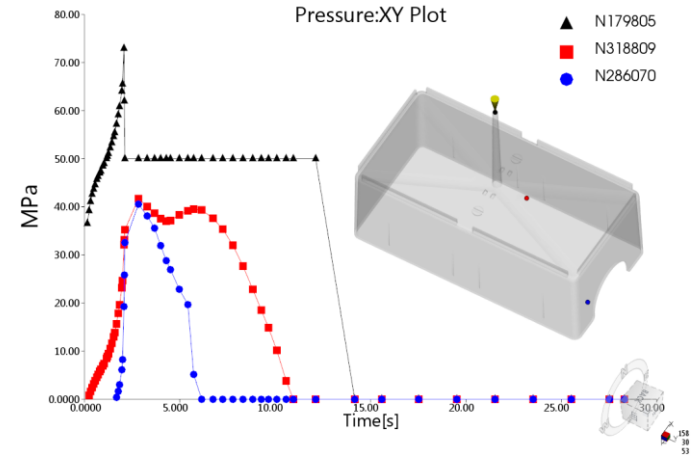
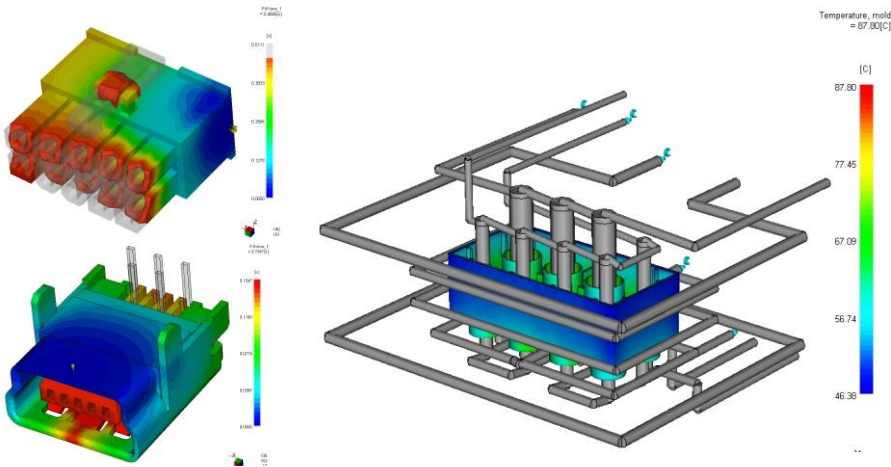
Our offer

- We carry out *tests* on materials and moulds *according to your requirements*
- This can be done with our moulds and equipment or with hardware provided by the customer
- The *integration* of inline *measurement methods* (e.g. thermography, colour...), additional sensor technology (e.g. temperature, pressure, force, deformation...) or carrying out a *DOE* are possible at any time

Industrial Service: Injection Moulding Simulation

Our capabilities

- We have more than 20 years of experience in injection moulding simulation
- During this time, countless issues have been dealt with in R&D projects and industrial contracts
- For the simulation we use Moldex3D and SIGMASOFT



Our offer

- We simulate your injection moulding process from simple mould filling, shrinkage and distortion to transient considerations
- On request, our experienced employees will provide suggestions for optimization of the component/mould design and explain the results in a comprehensible way
- We provide the results in the form of reports and/or viewer files

Simulative support from the idea to series production

Our capabilities

- We have more than 20 years of experience in injection moulding simulation
- For the simulation we use Moldex3D and SIGMASOFT

Our offer

- We accompany your product simulatively from the idea to series production
- From the initial fill analysis to the transient calculation of the injection moulding process, including moulds and suggestions for optimal processing parameters
- Compilation of an individual complete simulation package instead of individual simulations

Feature	Paket I: Basic Fill & Pack	Paket II: Advanced Fill, Pack & Warp	Paket III: Professional Fill, Pack, Cool & Warp	Paket IV: DigiTwin Transient
3D Model Component Required	✓	✓	✓	✓
Simplified layout of temperature control required	X	✓	✓	✓
Final component geometry and final temperature control layout required	X	X	✓	✓
Injection moulding tool required in 3D	X	X	X	✓
Simulation of different sprue positions	✓	✓	(✓)	(✓)
Fill ability, pressure losses	✓	✓✓	✓✓✓	✓✓✓✓
Clamping force, balancing	✓	✓	✓	✓
Location of weld lines, air pockets	✓	✓✓	✓✓✓	✓✓✓✓
Global Fiber Orientation	✓	✓	✓	✓
Gate Geometry, Gate Variants	X	✓	✓	(✓)
Shrinkage & Warpage	X	✓	✓✓	✓✓✓
Influence of Fiber Orientation on Shrinkage & Warpage	X	(✓)	✓	✓
Consideration of the influence of a hot runner system	X	X	✓	✓✓
Suggestions for tool optimisations	X	X	✓	(✓)
Consideration of a cascade, inserts ...	X	(✓)	✓	✓
Process simulation, setting and non-productive times, influence of the real mould / influence of the injection moulding parameters on the component properties including shrinkage and distortion	X	X	X	✓
Development stages:	Pre-Development: Article Construction	Pre-development: Mould design	Design Freeze: Mould design	Process simulation: Process parameter and optimization
Simulation Quality and Prediction Accuracy:	+	++	+++	++++
Costs for mould modifications and troubleshooting:	€	€€	€€€	€€€€

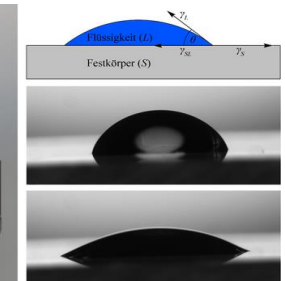
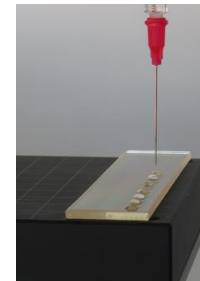
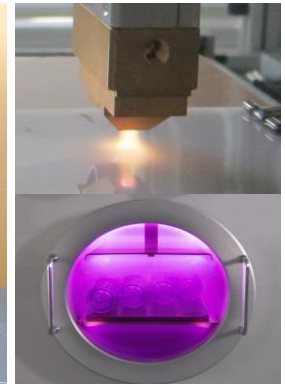
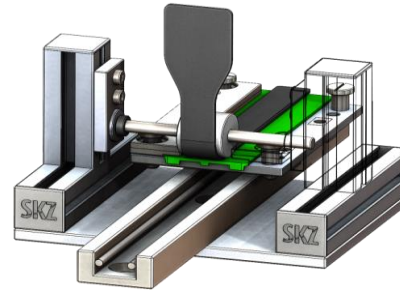
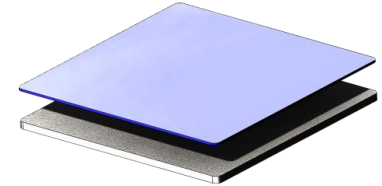
Examples of Service Packages

Service Package:

Adhesion

Services

- Sampling of *hard/hard or hard/soft composites*
- Production of *adhesion test* specimens according to *VDI219*
- DOE-supported execution of test series and variation of processing parameters
- *Correlations* between processing parameters and liability
- 2-component process or cold-inserted, pre-moulded part
- *Adhesion tests*
→ e. g. tensile, shear and peel tests
- *Storage tests* and determination of the influence on adhesion,
→ e. g. hot and/or media storage, climate change test, ...
- *Surface pre-treatment* to increase adhesion,
→ z. B. Corona, Plasma, VUV...

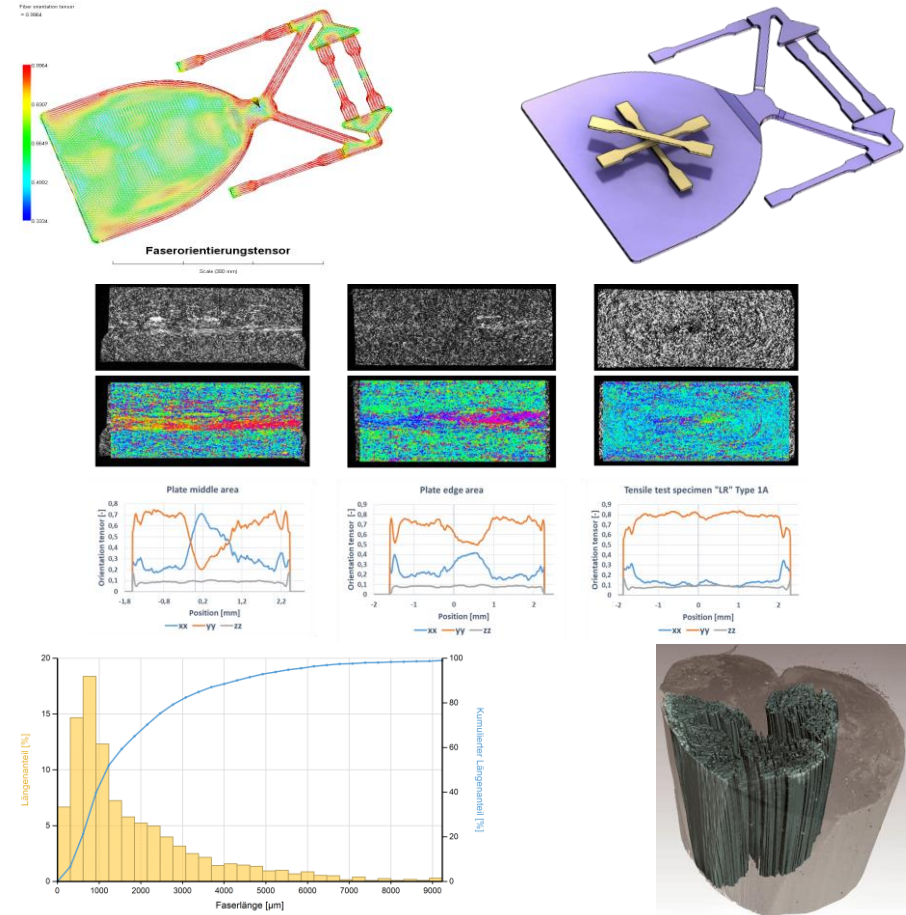


Service Package:

Fiber-Reinforced Thermoplastics

Services

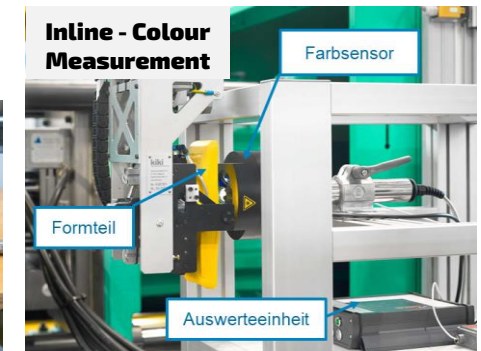
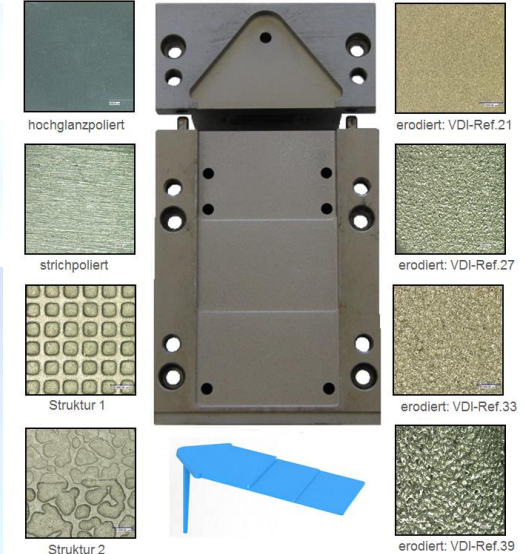
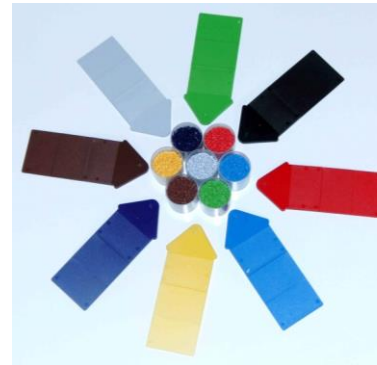
- Injection moulding of (special) test specimens and components
- Made of long or short fibre granules or in the direct process (FDC)
- Material comparisons or execution of test series (parameter variations)
- Ashing to expose the fibrous skeleton
- Determination of fiber length distribution and fiber content
→ also, on samples provided by the customer
- CT analyses to determine fiber orientation
- Preparation of test specimens in 0°, 45°, 90° to the direction of flow
→ e.g. milling, water jetting
- Mechanical tests
- Determination of weld seam strength
- Simulation of fiber-reinforced components



Service Package: Colouring

Services

- Colouring with liquid colour or masterbatch
- Use of state-of-the-art, leak-free liquid colour dosing systems
- Use of different mixing screws and/or static mixing nozzles
- Inline Colour Measurement
- Inline Homogeneity Measurement
- Evaluation of colour change processes
- Influence of processing parameters on colour values/homogeneity
- Influence of colours on flow properties, or mechanical properties
- Influence of different surface structures on colour measurement values
- Comparison of laboratory readings with inline colour measurement

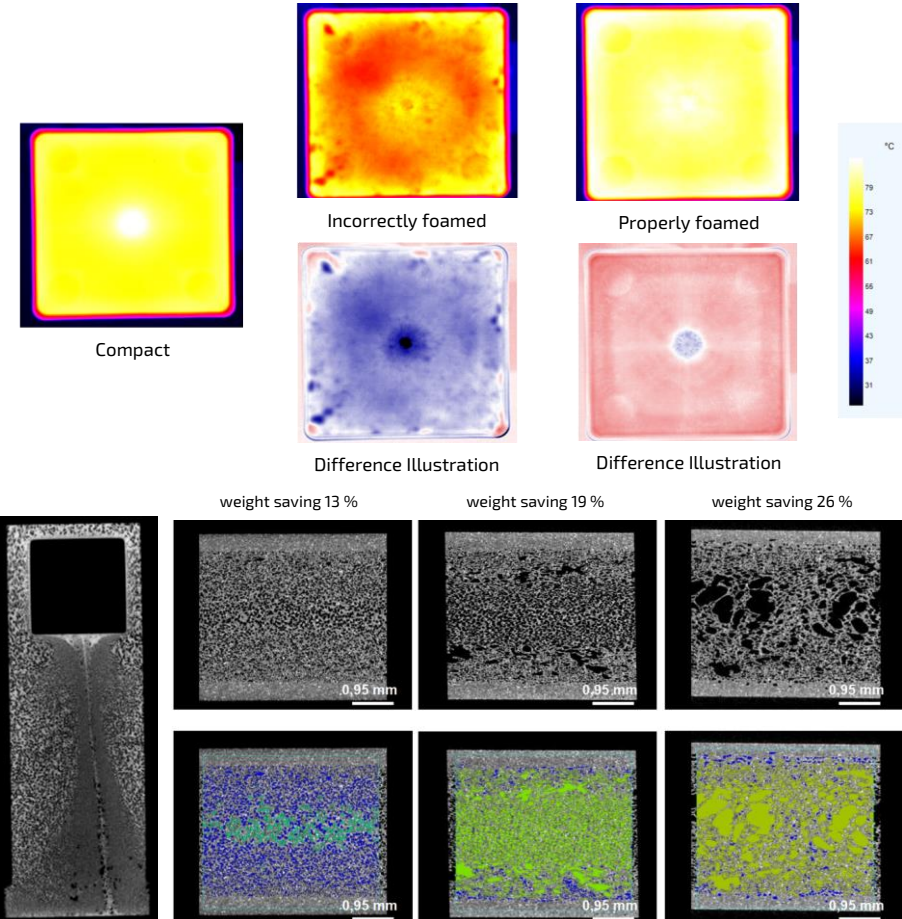


Service Package:

Foaming

Services

- Production of test specimens and components using the *TSG process (CellMould)*
- Execution of *test series* with variation of processing parameters
- Determination of *foamability and foaming degree*
- *Physically or chemically foamed*
- Foaming with *microcapsules*
- Combination of different foaming processes
- *Inline thermography* for assessment and monitoring of the foam structure
- *CT analyses* for qualitative and quantitative assessment of the foam structure
- Microscopy of the foam structure

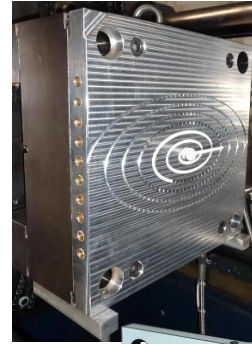


Service Package:

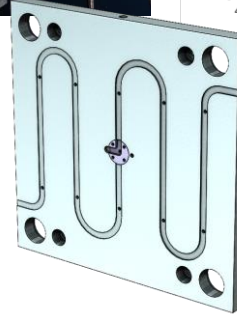
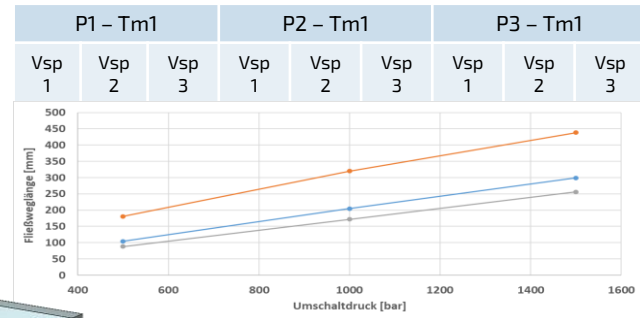
Flow behaviour

Services

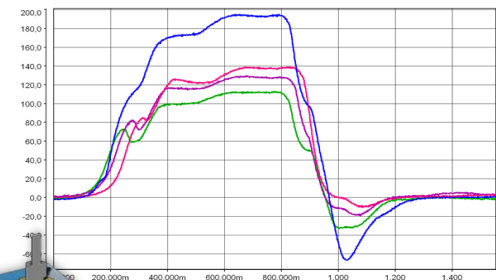
- Comparison of practical fluidity under process conditions
- Influence of the processing parameters on the flow path length (melt/mould temperature, injection speed, etc.)
- Creation of flow path/wall thickness diagrams
- Comparison of pressure losses between different process parameters and/or materials by means of an inline measuring nozzle
- A wide variety of flow path test specimens
- Laboratory Measurements MVR/MFR, HKR & Plate/Plate, Viscosity Number...



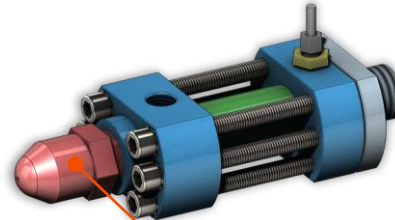
Flow Spiral – Changeover Pressure



Differential Pressure Curves PA6.6

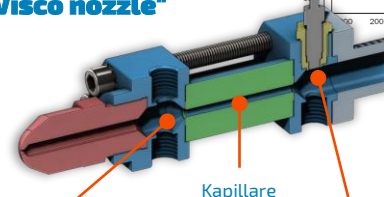


Trial	Humidity [%]
Blue	0,055
Red	0,116
Violet	0,204
Green	0,395



Machine nozzle

"Visco nozzle"



Pressure/Temperature Outlet

Kapillare

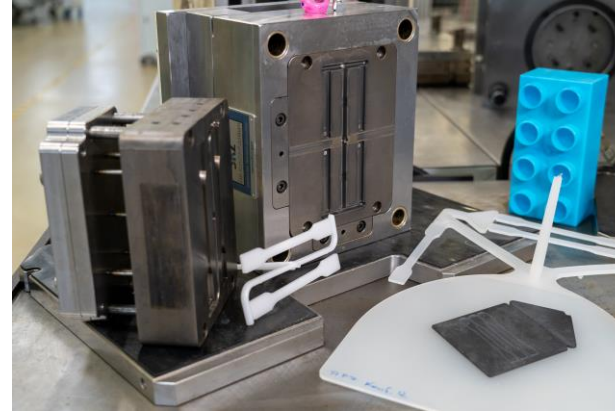
Pressure/Temperature Inlet

Service Package:

Sampling of substitution materials

Services

- Sampling thermoplastics / *alternative materials*
- Comparison to current series material
- *"Pre-sampling" and pre-selection* in the SKZ before a machine capacity is used in production
- *Sample/test packages* in accordance with specific customer requirements, e.g.
 - Test Specimen Manufacturing & Mechanical Testing
 - Process window, cycle time, etc.
 - Weld seam strength/quality
 - Surface quality
 - Demoulding behaviour
 - Shrinkage
 - ...
- *Neutral, external expertise* and evaluation based on quantifiable criteria

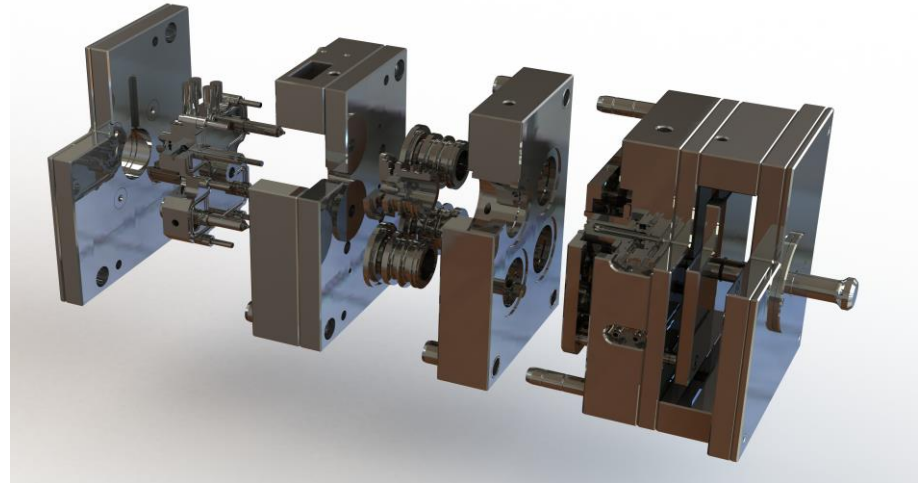
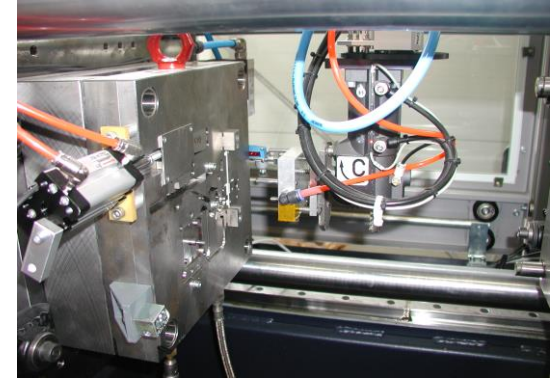
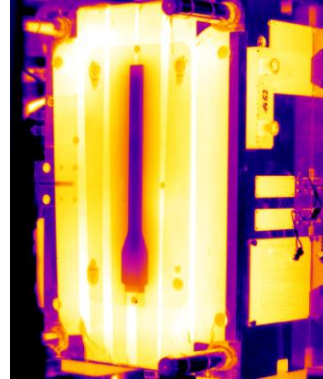


Service Package:

Sampling of (series) moulds

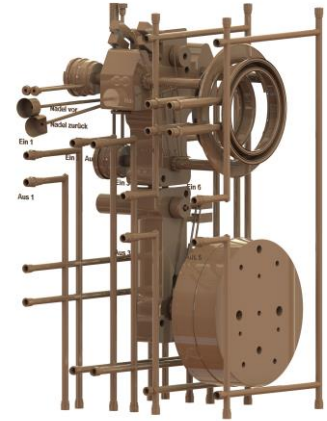
Services

- Sampling of series moulds in the technical centre of the SKZ
- Use of SKZ pilot plant machines with the latest control systems from 500 – 5.000 kN clamping force
- No occupancy of own machine capacities
- Parameter and/or material studies in a controlled, neutral environment
- Determination of process windows and correlations to component quality (DOE)
- Filling studies, sealing time determination, closing force requirement/mould breathing, ...
- Use of all test and analysis methods available in the SKZ
- Implementation of inline measurement methods
- Involvement of production staff (Trouble training, start-up moulds & optimization of processes...)



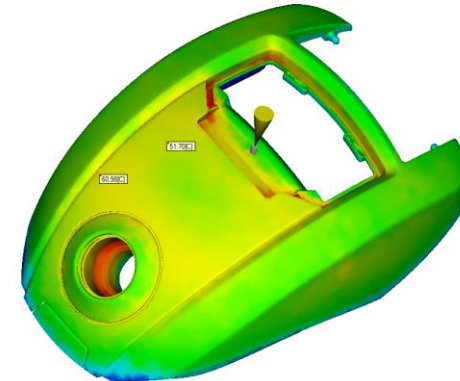
Services

- Simulative support from the beginning and in all iteration loops
- Evaluation of initial design studies regarding injection moulding design and manufacturability
 - Pressure drops, fill ability, weld lines, ...
 - Early identification of problem areas
- Simulation of the first mould concept
 - Connection, temperature control
 - Shrinkage & warpage analysis
 - ...
- Process simulation of the entire mould and virtual determination of optimal injection moulding parameters
 - Transient viewing
 - virtual DOE
 - ...
- Simulation of the final mould concept



Temperature, mold
= 65.00[C]

[C]
65.00
55.00
45.00
35.00
25.00



Scale (300 mm)

Services

- Sampling of *Recompounds*
- *Influence of Regranulates* on processing or regranulate components
- *Comparison* to Series/Virgin Materials
- Processing by hot and/or cold runners
- Evaluation of processing behaviour, e.g.
 - Injection and/or cavity pressure
 - Cycle time
 - Dosing behaviour
 - ...
- Influences on:
 - the flow behaviour
 - the surface quality
 - weld Lines - process consistency
 - ...
- Testing/Analysis:
 - Mechanical, thermal, chemical, ...
 - Storage tests: heat, temperature changes, climate, etc.
 - ...
- Colouring tests (masterbatch, liquid colour)



Thank you for your attention



Your contact persons

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