# New ways of induction heating in the injection moulding process

MicroMountains iNNOVATION fORUM

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Villingen-Schwenningen

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# Agenda

- About us
- Variothermal process control
- Induction heating in plastics processing

  Focus: Ceramics in injection moulding tools
- Details, trivia and preview on future applications

## Actuators

- Piezoelectrical Ultrasonic Motors
  Linear and Rotatory Travelling Wave Actuators
- Electrodynamic Actuators
  Linear Direct Drives
  Small Scale Actuators with Moving Magnets

## Precision Injection Molding

- Moulded Components
  Design and Construction
- Tool Design and Construction
- Variothermal Process Control by Inductive Heating
- Injection Moulding of Small Scale Parts
- Polymer Bound Magnets

## Design Methodology

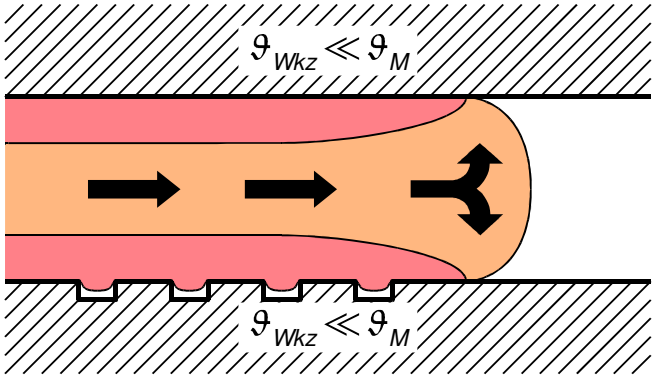
- Construction and Design using 2D- and 3D-CAD
- FEM Simulation
- Rheological Simulations
- Coupled Field Simulations
  electro-magnetic
  electro-magnetic-thermal
  piezoelectric-dynamic
- Metrology and Verification
- Reliability of Small Scale Actuators

## Optical and Mechanical Sensors

- Non-Contact Distance Sensors
- Surface Measuring Sensor
- Thickness Measurement Sensor

# Variotherm mould temperature control

## Isothermal process control

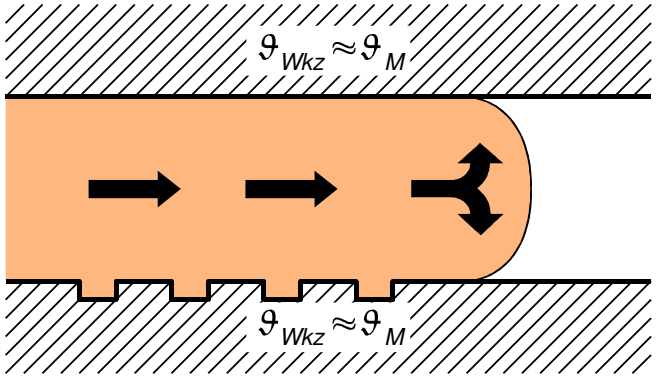



Polymer melt

Solidified melt

Constant mould temperature

## Variothermal process control




Polymer melt

Time-varying mould temperature

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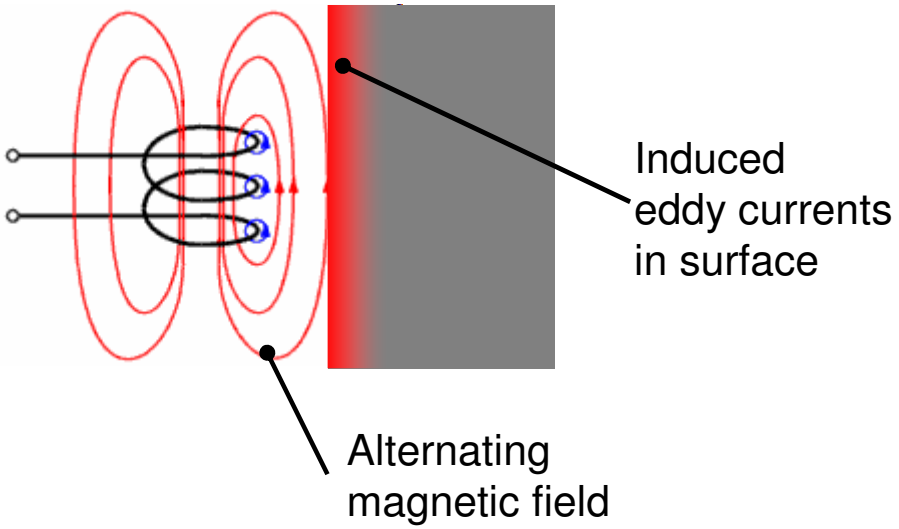
# Induction heating

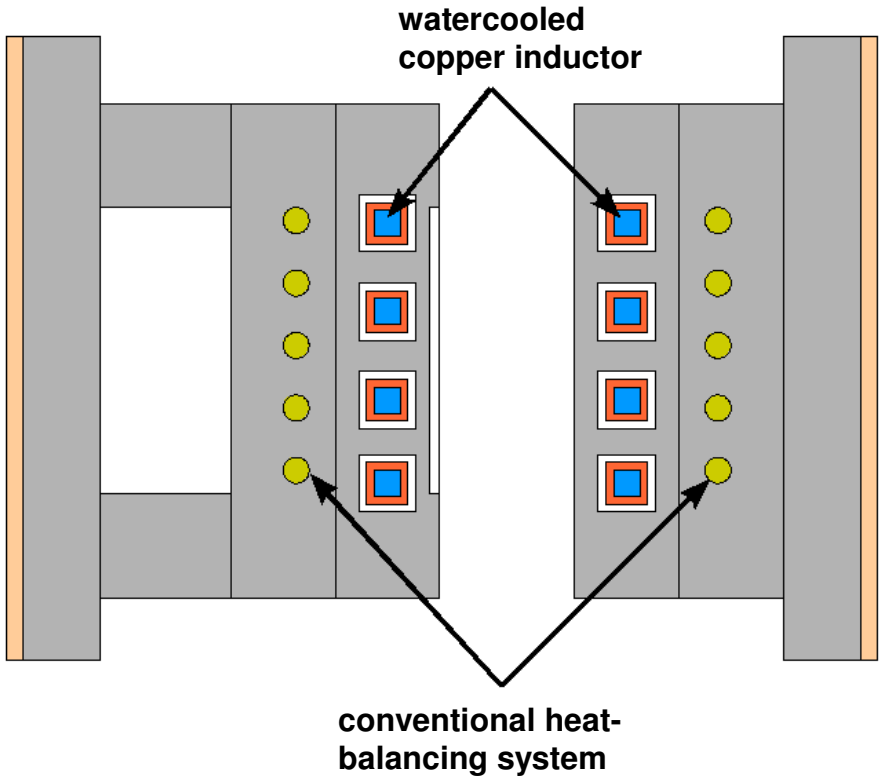
## Principle

- Electric transformer:
  „short circuit on secondary side“
  ⟹ eddy currents


- AC generated high-frequency electromagnetic field



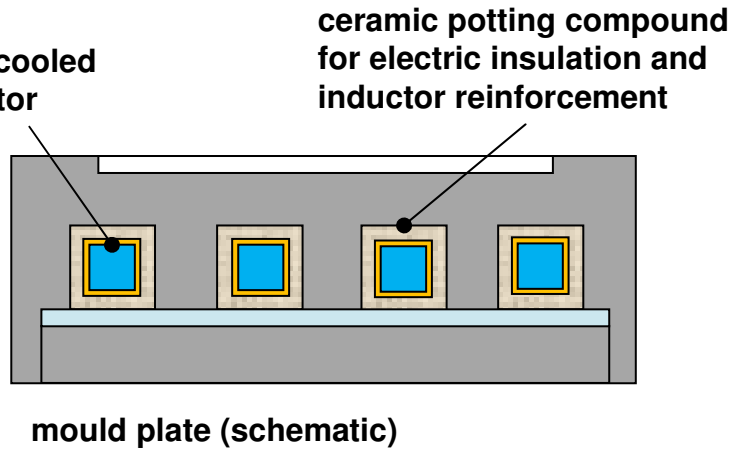
# Mould-integrated induction heating




Dynamic mould temperature by **thermal conduction**:

⇨ induction heating provides **high heat flux** due to its surpassing **power density**

# Use of ceramics as insulating material: ceramic potting compound




mould plate (schematic)

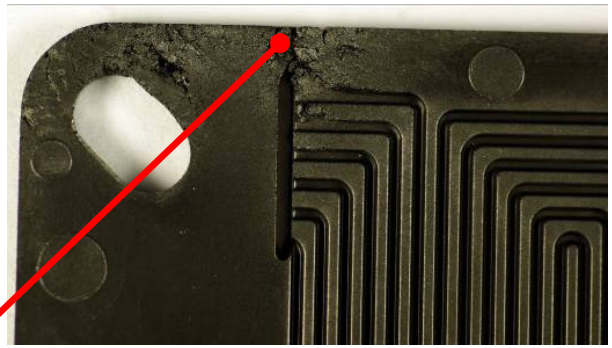
Separate channels for mould cooling needed

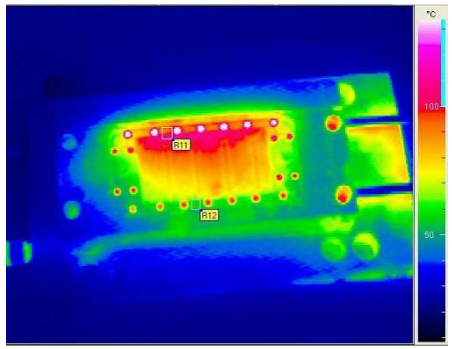
⇒ conflict:

**mould stiffness vs. thermal dynamics**

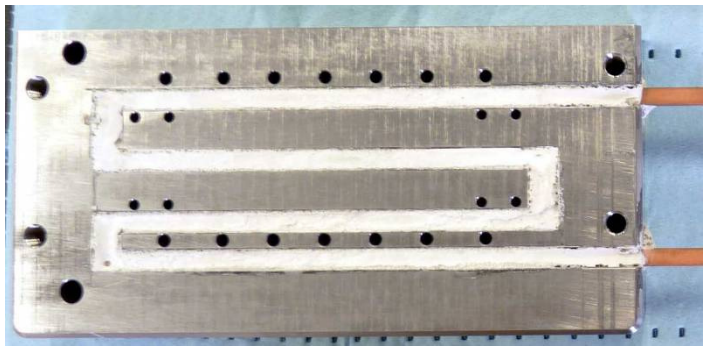
# Use of ceramics as insulating material: ceramic potting compound

**Example: mould for fuel cell bipolar plates**

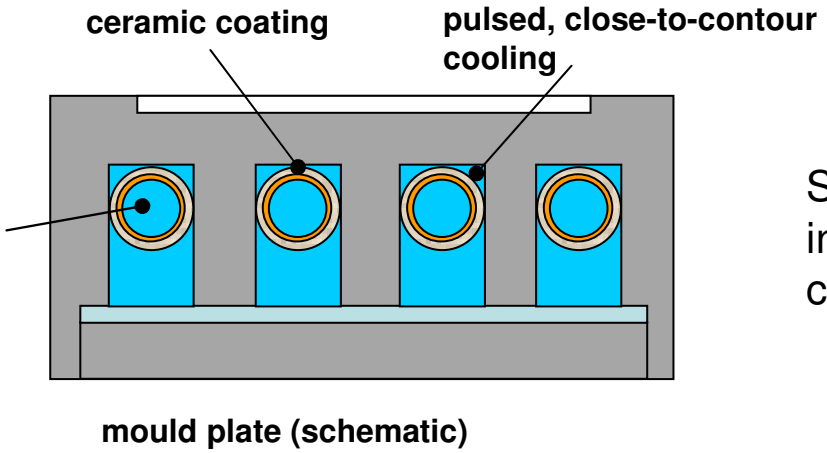




**Joint lines without induction**

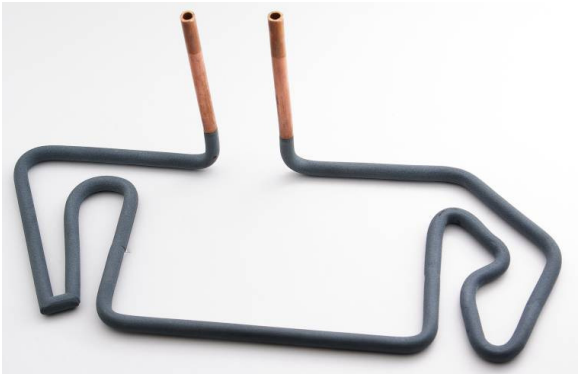


# Use of ceramics as insulating material: ceramic coating




Same channels for inductor and mould cooling

**Example:**

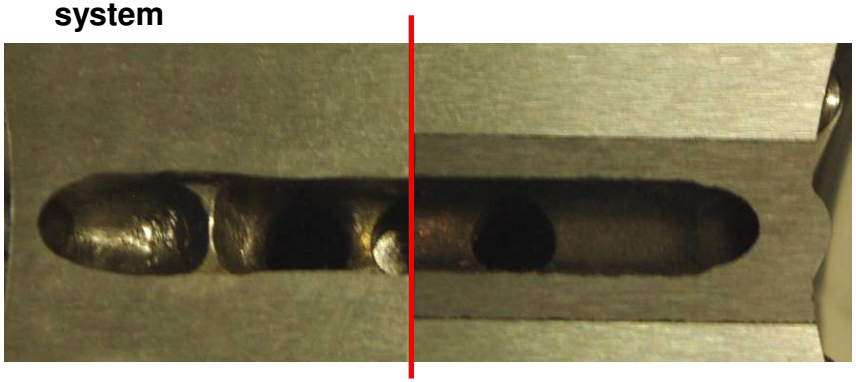


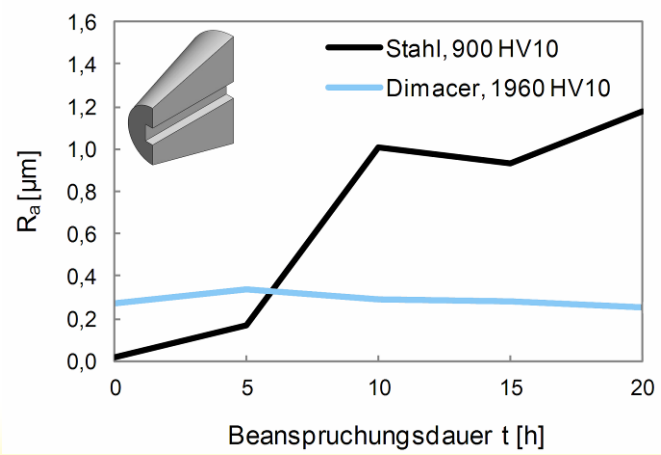
**improved mould stiffness and thermal dynamics (both heating and cooling)**

# Dimacer® : ceramics for injection moulding tools machinable high performance ceramics


**Wear on a conventional runner system**

**Ceramic gate insert (eroded)**






Bilder:
IFKB/Leroxid

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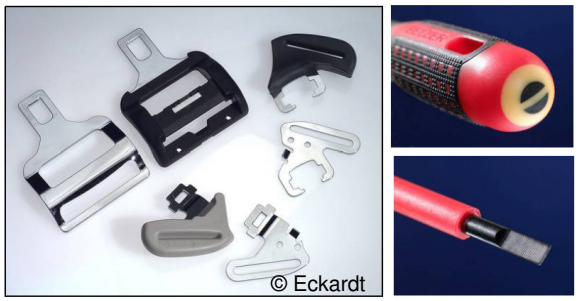
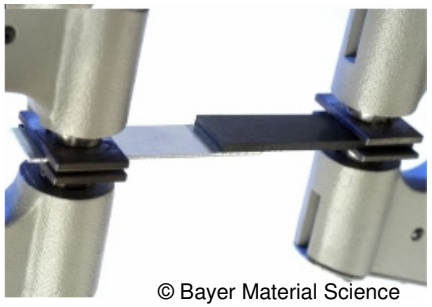
# In-mould heating of steel inserts by induction heating




**Examples of hybrid parts**




**Lap shear test**

**Current research project:**
use of electrical discharge machinable high-performance ceramics for electromagnetically transmissive moulding tools

IFKB IKFF FISCHER KUNSTSTOFF-SPRITZGUSS OxiMaTec Innovative Werkstoffe in bester Form Leroxid Erodierbare Keramik Leonhardt Graveurbetrieb Qualität hat ein Zuhause.

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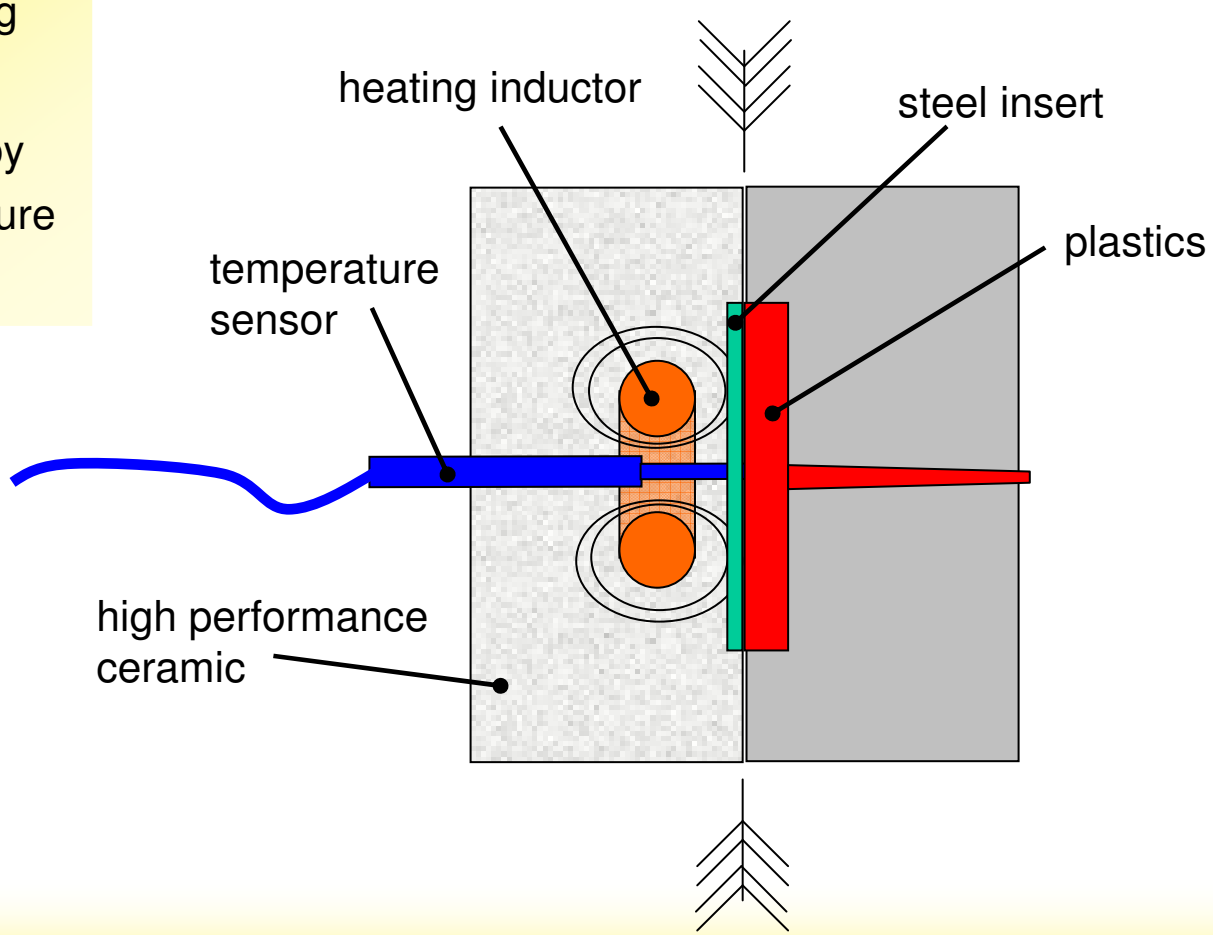
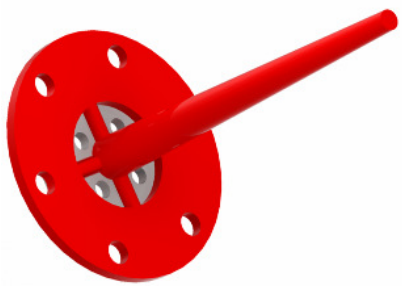
# In-mould heating of steel inserts by induction heating

**Target**

- In-mould pre-heating of the insert part
- Process governed by measured temperature of the insert part




Injection moulded hybrid part





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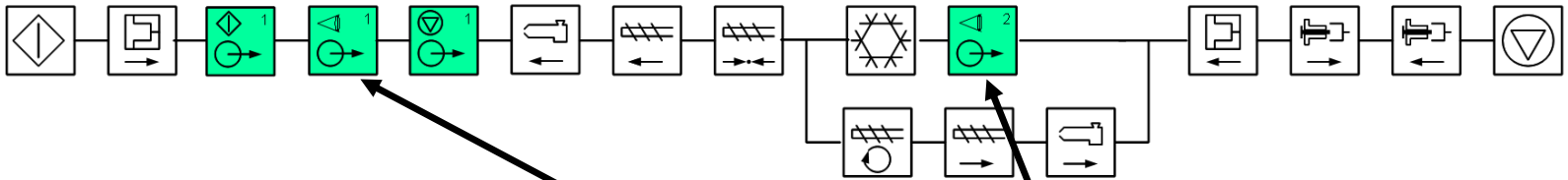
# Details & trivia


injection moulding machine

induction generator

thermocouple amplifier

**ARBURG SELOGICA:**



both temperature controlled heating and cooling
without external control unit

# Preview on possible applications


Processing of insert parts


Processing of LSR by multi-component injection moulding


Variotherm RTM-Process