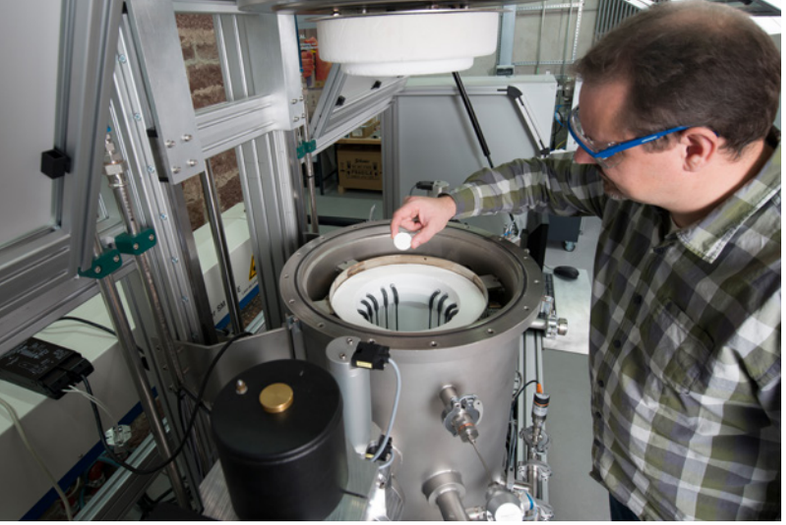

Service Offering

Fraunhofer Center HTL optimizes sintering processes with a view to optimum product quality and minimum manufacturing costs. The optimized process parameters are obtained by measurements in laboratory measuring systems (TOM systems) and FE simulations based on these measurements. If required, measurements are carried out on the production furnace to determine additional furnace data relevant for the optimization.

Process parameters to be optimized are:

- Temperature cycles
- Composition and flow velocity of the kiln gases
- Kiln furniture and, if necessary, release agents
- Setting plans

If required, the thermal treatment steps preceding sintering, such as drying and debinding, are also optimized at the HTL. The suitability of green bodies for the sintering process can be evaluated using special measuring methods. If necessary, the development of sintering materials, e.g. with suitable sintering additives, to achieve optimum sintering results.

Contact

Dr. Holger Friedrich
Phone +49 921 78510-300
holger.friedrich@isc.fraunhofer.de

Heiko Ziebold
Phone +49 921 78510-393
heiko.ziebold@isc.fraunhofer.de

Fraunhofer Center for High Temperature Materials and Design HTL
Gottlieb-Keim-Straße 62
95448 Bayreuth
www.htl.fraunhofer.de

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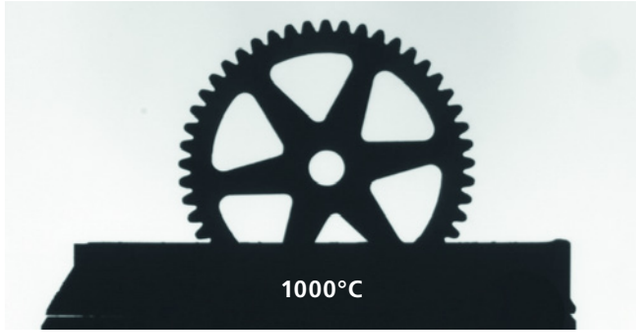
Optimization of Sintering Processes



Sintering Processes

For all materials produced by powder metallurgy, the sintering process contributes significantly to product quality and manufacturing costs. It must be carefully optimized to achieve the following goals:

- Part geometry close to final shape
- Homogeneous microstructure
- Low property scatter
- Low scrap rates
- High reliability
- Low manufacturing costs
- Favorable CO_2 footprint

In order to optimize the process parameters for sintering special methods have been developed at Fraunhofer Center HTL, which allow targeted identification of the optimum temperature cycle, furnace atmosphere and setting plans. They are applicable for the following materials:

- Oxide ceramics
- Non-oxide ceramics
- Silicate ceramics
- Refractory materials
- Sintered metals

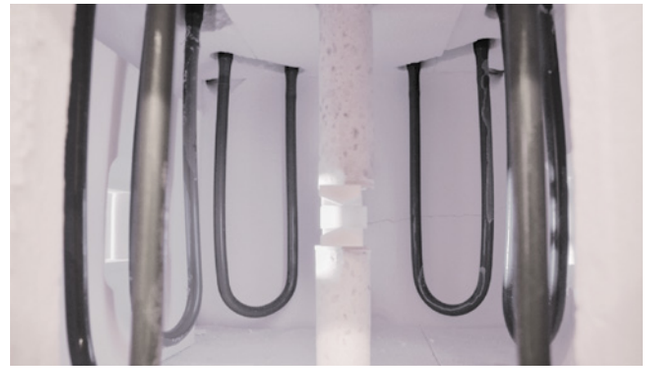
Procedure

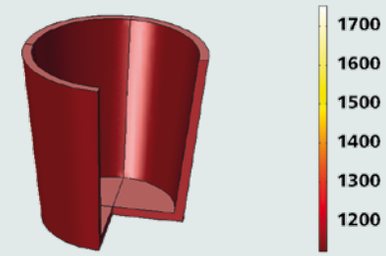
The optimization of the process parameters takes place in three steps:

1. First, the industrial sintering process is simulated in so-called ThermoOptic Measuring (TOM) systems. For this purpose, the HTL has various TOM systems with which oxidic, inert or reducing atmospheres can be set. The TOM systems allow all measurement data relevant to sintering processes with a high degree of reproducibility.

2. The measurement data recorded during the sintering process are parameterized and used as input in special finite element models. By means of FE simulation, the process parameters are optimized. This primarily includes the temperature cycle, but also the interaction of the sintered material with the kiln furniture. The optimized conditions are verified on the TOM systems.

3. Finally, the optimized process parameters are transferred to the production furnace. Temperature gradients, setting plans and gas flows are taken into account. If required, these can be recorded at the production furnace using a mobile measuring stand.





Technical Data

Depending on the application, in-situ measurements for sintering up to temperatures of 2200°C can be carried out in the TOM systems. The FE simulation is carried out by means of formal kinetic methods in thermal-mechanical coupled models with the software COMSOL.

In-situ metrics

- Sintering shrinkage (optical measurement, reproducibility 0.02 %)
- Sintering distortion (up to 20 measuring positions, 2D or 3D)
- Thermal diffusivity (laser flash measurement)
- Viscous moduli (uniaxial viscosity and Poisson's ratio)
- If applicable, weight changes, wetting properties, etc.

Sintering atmospheres

- Air
- Gas burner atmospheres
- Inert gases
- Reducing gases (also 100 % hydrogen)
- Overpressure (up to 30 bar)
- Vacuum