Fraunhofer ICT

Microwave and plasma technology

Heating plastics with microwaves

Fraunhofer ICT's expertise in the area of microwave and plasma technology goes far beyond simple processing technologies. It includes the development of production units and measurement technology, accompanied by numerical simulation of the electromagnetic field and the resulting heating. Particular attention is paid to the reproducible and controlled application of microwaves.

Limitations of conventional methods for heating plastics

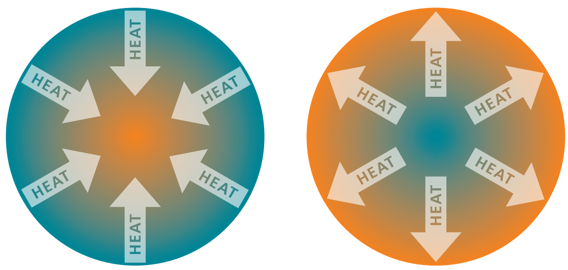
Most plastic processing is carried out under heating, and the heating time is limited by the process cycle time. Conventionally, hot air, contact heating or infrared radiation are used. These techniques heat the surface of the material, and the heat is transferred to the interior. Due to the low thermal conductivity of the plastics, this process is time-consuming. These heating techniques are energy inefficient and there is a risk of damaging the material on the surface.

Fast, non-contact heating with microwaves

Due to their long wavelength, microwaves are able to penetrate deeply into many polymers. It is therefore possible to transfer heat deep into the material without contact. Heating occurs volumetrically and is relatively independent of thermal conductivity. Microwaves heat the material fast and energy-efficiently.

Microwave processes and their applications

- Annealing
- Foaming
- Preheating of resins, pellets and powders
- Plastification
- Direct and indirect welding and sintering
- Curing of resins, lacquers and varnishes
- Heating of preforms



Schematic comparison of conventional vs.microwave heating.

Success stories

Preform heating with microwaves using a conventional process

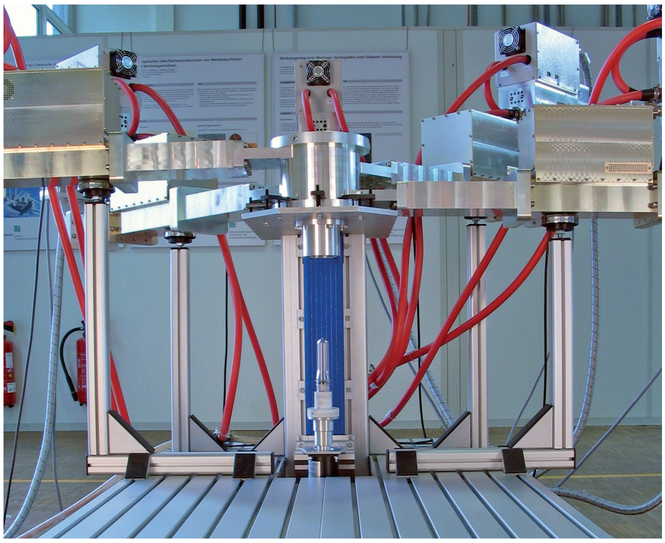
PET bottles are produced in a two-stage process. Preforms, produced separately beforehand by injection molding, are heated to the thermoelastic temperature by infrared radiation, and subsequently shaped into bottles. To avoid the crystallization of the transparent PET, heating occurs under high radiation power while the surface is systematically cooled. A maximum of only 20 % of the input energy is transferred into the product.

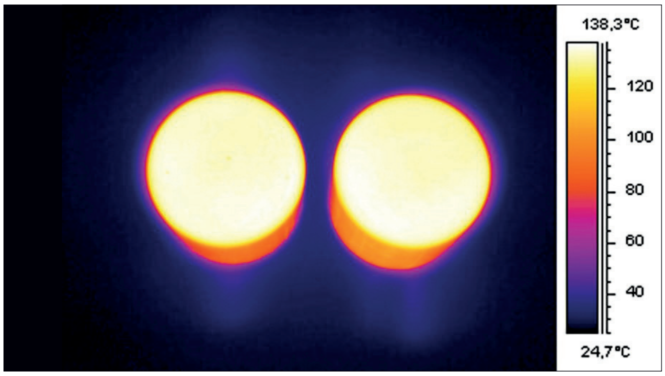
Microwave heating

The aim is to reduce heating times and increase energy efficiency, as well as to achieve a radially more uniform heating of the preform wall. The PET is heated in a microwave cavity generating a particularly high field strength. The preform is heated from room temperature to blowing temperature (around 110 °C) in less than 3 s.

Annealing of semi-finished products

Annealing is necessary to relax internal stresses in semi-finished products. The materials are heated by hot air to a temperature just below the crystalline melting point, and slowly cooled. Microwave heating can significantly accelerate the heating process for the sample e.g. for a POM rod of 70 mm in diameter from about 7 hours to about 8 minutes





Heating unit for preforms.

Our offer

- Consulting and know-how transfer
- Feasibility studies
- Dielectric measurement of product
- Numerical simulation of electric field and heat flow
- Process control
- Thermography
- Design and construction of demonstrators
- Testing and validation

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