TECHNISCHE HOCHSCHULE DEGGENDORF

µWaveHiSens

HIGH TEMPERATURE MEASURING USING LIGHT.

Weitere Infos

Abstract

Projekttitel/ Project title:

Microwave High Temperature Sensing for Additive Manufactured Metal Components (µWaveHiSens)

Einleitung/ Introduction:

Using the FDM process, a 3D printed part made of a metalpowder-polymerbinder-composite can be produced. This green part goes through further process steps, the chemical debinding and the sintering, to obtain a pure metal workpiece. During the conventional sintering process, the part gets heated up to 80 % of its melting temperature in an electric high-temperature furnace. This process can take more than 20 hours and needs a lot of heating energy.

Various publications showed that metal powders unlike metal bulk material can in fact absorb microwave energy and convert it into thermal energy. By replacing the conventional electric furnace with a microwave sintering furnace, process time and required heating energy can be drastically reduced.

Ziel/ Aim:

Since common temperature sensors, like thermocouples or resistance thermometers, are not applicable in microwave radiation due to the influence of the microwaves on the sensor materials, there is no effective way to monitor the temperature during the microwave sintering process.

The aim of this work is to develop a sensor system on optical basis to enable the temperature monitoring and ensuring the process stability of the microwave sintering.

Methode/ Method:

The Fabry-Pérot interferometer is an optical setup that allows to limit the transmission of incoming light beams based on resonance conditions. It consists of two partially transparent mirrors that act as an optical resonator. The light is reflected several times between the mirrors, causing interference of the partial beams and thus only light of a certain wavelength is transmitted. The setup of a Fabry-Pérot interferometer is shown in figure 1.

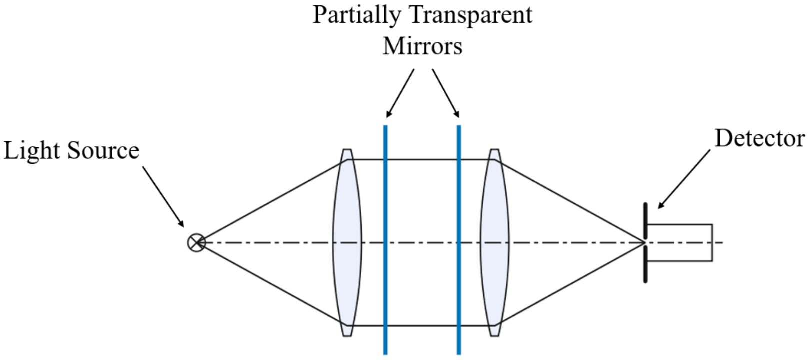

Figure 1: Schematic Layout of a Fabry-Pérot-Interferometer

Instead of two partially transparent mirrors, a thin plate of sapphire can be used to create an interference pattern due to the reflections on both sides of the sapphire.

Figure 2 shows the schematic of the Fabry-Pérot interferometer as a temperature sensor. Light from an LED is directed via one end of a Y-glass fiber splitter to a collimator, which creates a parallel beam path inside an alumina tube. A sapphire plate is attached to the end of the alumina tube at room temperature using a high temperature resistant adhesive. The light is partially reflected from both sides of the plate and directed into a spectrometer via the second end of the Y-fiber optic splitter.

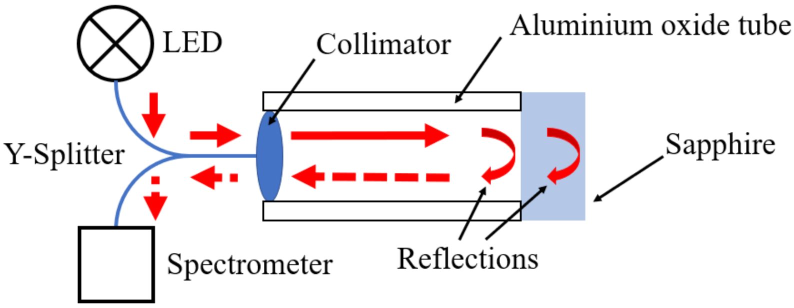

Figure 2: Fabry-Pérot-Interferometer as temperature sensor

Due to thermal expansion, the sapphire plate changes its thickness by varying temperature, which affects the optical path difference inside the sapphire and hence the interference spectrum. This allows the temperature to be inferred.

Ergebnis/ Result:

First measurements of the optical path difference in the range of 50 °C to 175 °C are shown in figure 3. The measured temperature shows great deviations of about 50 °C at lower temperatures and lower deviations of about 15 °C at higher temperatures.

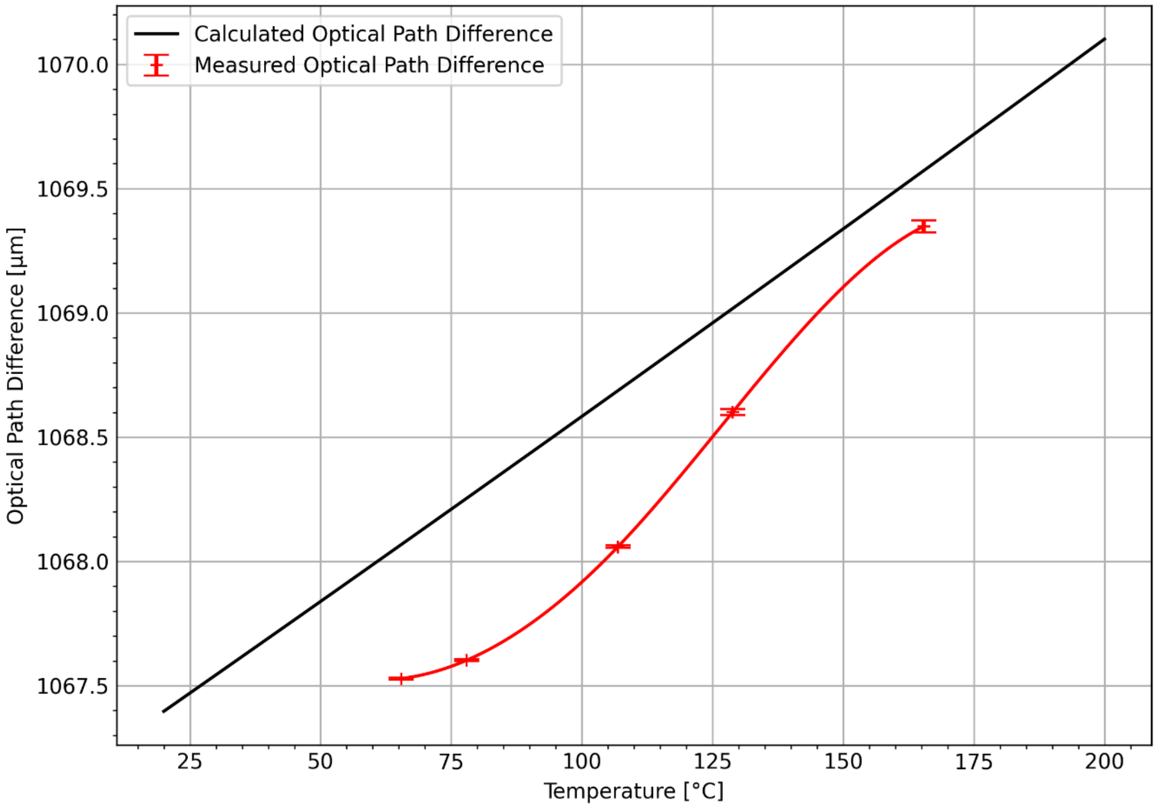

Figure 3: Comparison of measured and calculated optical path difference

Projektbeteiligte/ Project participants:

Technologiecampus Teisnach Sensorik

Projektpartner/ Project partners:

Gefördert durch/ Funded by:

Logos/ Logos:

insgesamt maximal 450 Wörter/ limit of 450 words in total