Development of an Optical Differential Scanning Calorimetry Setup for Determining the Specific Heat Capacity at High Temperatures

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Modern material science is of high importance for further development in many fields. The increase of the process temperature of thermal energy conversion processes and therefore the development of highly temperature stable materials is one of the most important issues on the way to higher efficiencies. This, however, requires the development of materials, which are more stable towards high temperature areas. One example for such successful material development are thermal barrier coatings (TBC) used for gas turbine blades. In some cases under operating conditions, the temperature of the TBCs is far above the melting point of the protected body material. In additive manufacturing techniques as laser sintering material is locally molten by a laser beam. Hereby, an increase of precision and the enhancement of process control are aims of further development.

In order to achieve improved process control, the reliable prediction of the heat conductive behavior of different materials at harsh operation conditions and therefore the exact knowledge of material parameters at high temperatures above 1000 °C and up to 2000 °C is needed. In this regard, the two material properties thermal diffusivity and the specific heat capacity are important. For the determination of the thermal diffusivity even at high temperatures above 2000 °C, the laser flash method can be used as a verified measurement method. The specific heat capacity at temperatures below 1000 °C can already be measured by differential scanning calorimetry (DSC). Today, in most DSC setups thermocouples are utilized for the necessary temperature measurement. However, up to now, thermocouples are not suitable for higher temperatures. For this reason, a reliable measurement method to provide verified information about the specific heat-capacity of material samples at temperatures above 1000 °C is still needed.

To resolve this lack of information in future, within the project “Optical Differential Scanning Calorimetry For Modern Material Science At High Temperatures (OptiMa)” it is intended to develop a DSC method for measurements at temperatures between 1000 °C and 2000 °C. In this new built DSC setup (Fig. 1), several optical detectors like radiation thermometers and thermographic cameras will be tested and analysed in order to gather the required temperature information without fault-prone thermocouples. Simultaneously, different methods of sample heating will be tested e.g. inductive heating and laser-heating. Furthermore, it is planned to utilize the triple-cell sample holder design, which reduces the number of necessary measurement cycles [1, 2].

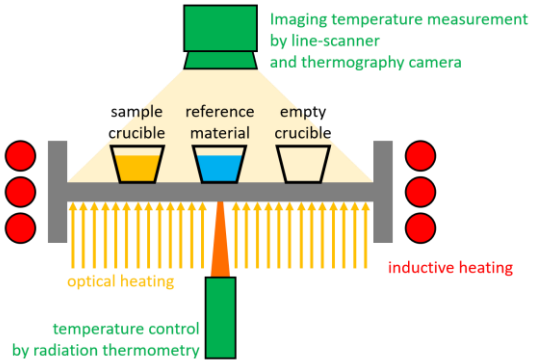

Fig. 1. Principle drawing of the new DSC setup with optical temperature measurement for determination of the specific heat capacity at temperatures between 1000 °C and 2000 °C.

Acknowledgment

This Project (contract number: 13FH070KX0) has been sponsored as a part of the funding program

Forschung an Fachhochschulen by the German Federal Ministry of Education and Research (BMBF).

Significant references

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