

Infrared heating for a sustainable powder coating technology

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Industrial processes need to be transformed into sustainable alternatives. For powder coatings, which traditionally rely on gas or oil heating systems, infrared radiation can deliver the required process heat. The aim of the NAPUBEST project is to evaluate the possibilities of infrared radiation in the powder coating process. In our laboratory, we realized a prototype of an IR oven for test measurements.

1 Introduction: NETZ

As part of the high-tech agenda of Bavaria, the Bavarian State Ministry of Science and Art has granted start-up funding of five million Euro to Aschaffenburg University of Applied Sciences to establish a technology transfer centre for sustainable energy (NETZ) in the neighbouring city of Alzenau (see Fig. 1). The funding commitment is valid for the period from October 2023 to September 2028.



Fig. 1 Inauguration ceremony of the Technology Transfer Centre for Sustainable Energy in Alzenau (NETZ).

NETZ is targeting the Agenda 2030, the UN Resolution from 2015, which includes 17 Sustainable Development Goals (SDGs) for a more sustainable future. The SDGs contain topics like “Affordable and Clean Energy” as well as “Sustainable Cities and Communities” and “Responsible Consumption and Production”. NETZ supports local companies and communities on their way to a sustainable energy transition. [1]

2 NAPUBEST

As part of this new institution, the NAPUBEST project (German abbreviation for “Nachhaltige Pulverbeschichtungs-Technologie” which means “Sustainable Powder Coating Technology”) is focused on the use of infrared heaters to reduce or

replace, respectively, fossil fuel consumption in powder coating systems (see Fig. 2). In a highly reflective octagonal housing, the infrared radiation is homogenized and can be effectively absorbed by the coating of the samples. The strong dependence of the IR absorption on the geometry of the irradiated parts as well as on the colour and type of the coating powder has to be considered before the implementation of this innovative heating. [2]



Fig. 2 The logo of the NAPUBEST project.

The high reflectivity of silver-coated reflector sheets facilitates the homogenisation of infrared radiation inside the oven (see Fig.3). On the other hand, the absorption of powder-coated samples in different paint colours has an impact on the heating efficiency.

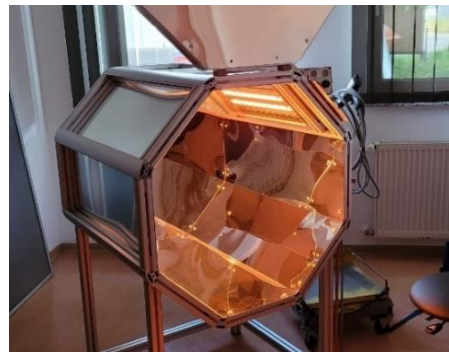


Fig. 3 Prototype of IR oven with high reflective sheets

The infrared lamps were purchased from the company EXCELITAS NOBLELIGHT. The reflection walls are made of ALANOD material.

3 Optical measurements of coated samples

Measurements in the NAPUBEST prototype system will be compared with optical simulations of the setup to get the simulation parameters in agreement with reality. This provides a good foundation for the layout of future industrial processes.

Measuring the reflectivity of this kind of samples delivers not only specular reflection but also a high fraction of diffuse reflection (see Fig. 4). This has to be taken into account in the simulations.

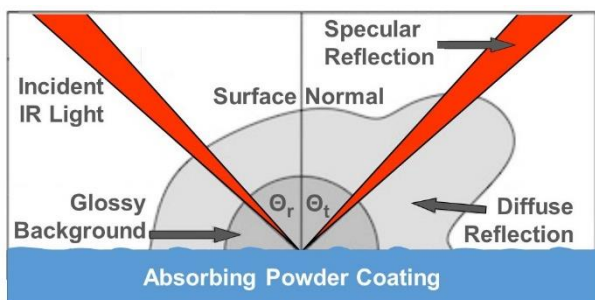


Fig. 4 Optical scheme of specular and diffuse reflection

In collaboration with Wrexham Glyndwr University, the required optical properties of industrially relevant powder coatings were determined from the ultraviolet to the infrared spectral region. Fig. 5 shows the measurement equipment as well as the samples of powder coatings in different colours. While for the white coating the diffuse reflection is quite high, at least in the visible part of the spectrum, for the black sample this portion is less pronounced. The reflection depends on the colour as well as on the chemical composition and the curing properties of the powder coating [3] [4].



Fig. 5 Reflectometer in Wrexham Glyndwr University and samples with powder coating in different colours.

The reflectivity has been measured for linearly polarized light with different orientations over a wide range of wavelengths and angles of incidence. The result for a relevant wavelength with respect to infrared curing can be seen in Fig. 6 exemplified for the grey sample.

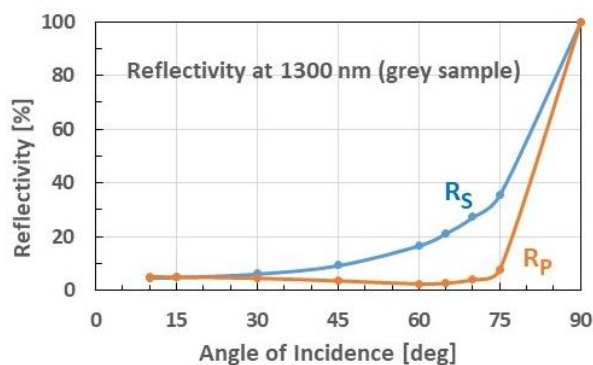


Fig. 6 Angular dependence of reflectivity for parallel (R_P) and perpendicular polarized IR radiation (R_S).

4 Summary and Outlook

The next steps are temperature measurements inside the IR oven on samples that differ in colour, surface roughness and geometry. In reality, most manufacturing parts are not flat but have distinct geometries (an example is given in Fig. 7). Therefore, it is important to consider how the angular dependence of the incident IR radiation affects the result of the curing process in dependence of the parts geometry.

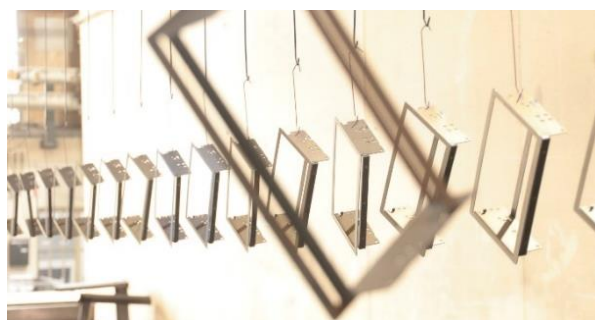


Fig. 7 Parts with powder coating on their way towards an industrial curing oven.

5 Acknowledgement

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