

Case Study

Phase transformations

in metallic samples

FlexiTherm

Quenching and deformation dilatometer as an *in situ* XRD sample environment

One of the most requested sample environment of HZG's High Energy Materials Science beamline (HEMS) at DESY in Hamburg is the **FlexiTherm**. It consists of a commercially available **DIL 805A/D Dilatometer**, provided by the company Bähr-Thermoanalyse GmbH, which was modified with special windows, to perform dilatometer measurements directly in the X-ray beam. This enables the experimentator to monitor expansion and contraction behaviour of samples during heating or cooling and simultaneously measure phase transformations of the material in the synchrotron beam. Hot deformation experiments in the beam are also possible.



Figure 2: Deformation dilatometer mounted at the beamline



Figure 1: Induction heating of a steel sample

Microstructure evolution during induction hardening of steels

The french **Institut Jean Lamour** is a research center for materials science and metallurgy. For a government-funded project, consisting of academic and industrial partners, the researchers of IJL carried out experiments at HEMS, focused on the heat treatment of steels by induction hardening.

The experiments were performed, to track *in situ* the microstructure evolutions during the heating of steels. The goal was to understand, how fast heating rates (up to 100 °C/s), like in induction hardening, influenced the microstructures of the material.

For example, the studied steels contained carbides with an amount of only a few percents. Due to the difficulty to observe these carbides, their dissolution during heating has almost never been studied before.

Development of new steel-based materials

The results, gained by these measurements, will enable the researchers at IJL to control the microstructures of their new, steel-based materials. This will help to optimize the processes of their elaboration and treatment in order to create materials with new and powerful properties.

Solving materials problems

With X-rays or neutrons

The German Engineering Materials Science Centre (GEMS) is a central user access platform, where the Helmholtz-Zentrum Geesthacht provides a worldwide unique infrastructure for complementary research with photons and neutrons. Instruments using synchrotron radiation are operated at the outstation at DESY in Hamburg, instruments using neutrons are located at the outstation at the FRM II Garching, near Munich.



Figure 3: PETRA III experimental hall at DESY, Hamburg



Figure 4: Experimental hall at FRM II in Garching, near Munich

GEMS provides you with state of the art materials analysis well beyond the capabilities of standard laboratory equipment:

- 3-D imaging (radiography, tomography)
- Residual stress measurements
- Analysis of phase transformations
- Characterisation of nanostructured hard and soft matter samples

Industry specific user support:

- Materials science support labs (sample preparation and characterisation)
- data analysis, secrecy agreements
- In situ sample Environments:
 - Furnaces
 - Cooling devices
 - Stress rigs
 - Dilatometer
 - Laser and friction stir welding devices