Chair of Metal Forming and Casting (*utg*)
TUM School of Engineering and Design
Technical University of Munich

ALL4ADI

Extending the range of applications of austempered ductile iron (ADI) by accounting for local material metallurgy, local stressability and including the simulation of solidification and heat treatment

Motivation

Austempered ductile iron (ADI) combines the excellent casting properties of cast iron with the mechanical properties of steel, so that the production of geometrically highly complex components is possible with a 10 % weight reduction compared to steel due to the lower material density.

In particular, the heat treatment process allows the base material ductile iron (GJS) to be tailored to the specific requirements of a product, depending on the choice of temperature level, time and alloying elements. In addition, the use of ADI requires only up to 40 % of the energy needed for component production compared with steel components.

With the energy and climate crisis in mind, ADI is therefore a promising material for the future, as there is potential for energy savings both in production and in use due to the lower component weight. However, the production and design of ADI components is currently associated with many uncertainties. Above all, there is a lack of design and dimensioning data for the various ADI grades. As a result, the material is not widely used. The project consortium aims to counter this situation by taking a holistic view of the manufacturing process.

Approach

For the development of ADI components, it is necessary to be able to simulate both the local component solidification and the heat treatment with its process steps austenitization, quenching and ausferritization and to be able to predict the resulting microstructure and its mechanical properties locally.

For this, the industrial casting and heat treatment process is first captured. Time-temperature profiles are recorded on components during casting and heat treatment with the aid of thermocouples and then evaluated.

Based on this, heat treatment is being investigated on a laboratory scale at *utg*. A test rig is being developed for this purpose. With this, the specimen is heated and held at approx. 900 °C. The sample is then quenched to approx. 300 °C and held again. It is then cooled down to room temperature.

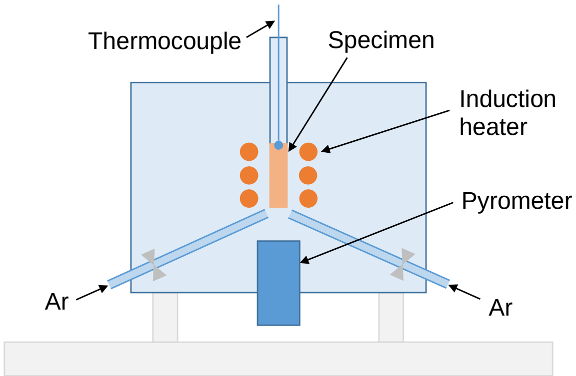

Figure 1: Sketch of the test rig for laboratory scale heat treatment

This makes it possible to vary the temperatures, holding times and cooling rates of the heat treatment for different alloy compositions. Subsequently, the resulting microstructures are examined and the mechanical properties are determined. This allows the identification of correlations between the parameters of the heat treatment, the alloy composition, the resulting microstructure and the mechanical properties.

Outlook

The aim of the project is to provide engineers with a design concept for ADI components. This will enable them to determine the correct heat treatment parameters, alloying elements and a suitable component geometry based on the product requirements.

Christoph Weidner, M.Sc.
Walther-Meißner-Str. 4
85748 Garching
christoph.weidner@tum.de
Tel. +49 89 289 13 764

Funding:
Bundesministerium für Wirtschaft und Klimaschutz

Project partners:
TU Clausthal
Fraunhofer-Institut LBF
ADI Treatments Ltd.
ACTech GmbH
AEROVIDE GmbH
FONDIUM B.V. & Co.KG
MAN Truck & Bus
MATPLUS GmbH
TEUTOGUSS GmbH
RWP GmbH
Foseco Nederland B.V.
Buchholz & Cie. Giesserei GmbH
Walzengießerei & Hartgusswerk Quedlinburg GmbH
Zanardi Fonderie S.p.a.