FERROUS METALLURGY
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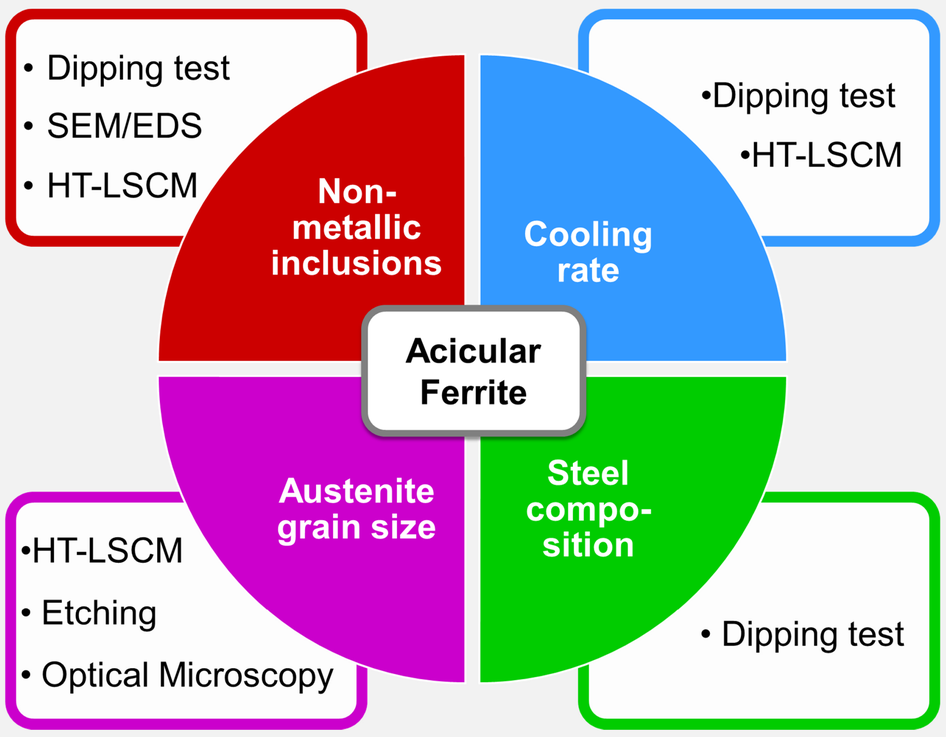
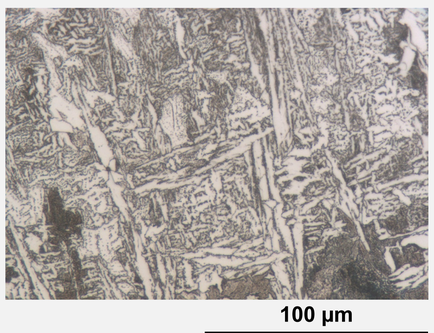
The Use of HT-LSCM for the In Situ Observation of Acicular Ferrite

Acicular Ferrite & Inclusions

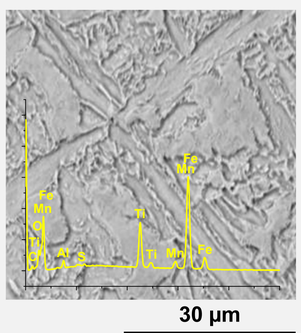
Acicular ferrite (AF) is a needle shaped, fine grained modification of ferrite, which nucleates intergranularly at non-metallic inclusions (NMI). The formation of AF is influenced by four main parameters: Steel composition, cooling rate, austenite grain size and NMI. These parameters are interacting strongly, making a systematic study necessary. The formation mechanism of AF is not clarified yet, making the production of AF microstructures in large industrial scale difficult.



Due to the fine grained structure of AF, it provides excellent toughness. By increasing the amount of this component in microstructure, the properties, especially the toughness, of HSLA steels can be optimized significantly.



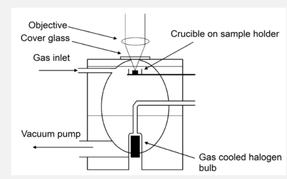
Special types of NMI are active nuclei for the formation of AF. Complex NMI are seen to act as more active nuclei for AF than single phase NMI. Particularly Ti- and Mn-containing NMI are described as active since they form Mn-depleted zones, which promote the formation of ferrite.



HT-LSCM & Inclusions

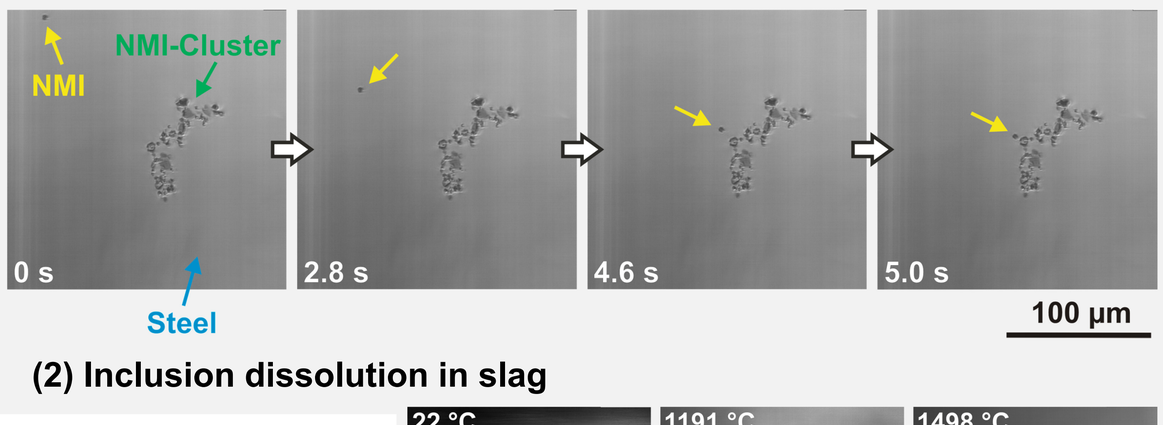
By the use of a **L**aser **S**canning **C**onfocal **M**icroscope attached to a **H**igh **T**emperature furnace (HT-LSCM) the in situ observation of various metallurgical reactions in solid and liquid state up to 1700 °C is possible due to the use of a laser as light source:

- Behavior of non-metallic inclusions (NMI) in steel or slag
- Phase Transformations such as austenite – (acicular) ferrite transitions
- Growth of austenite grains
- Reactions at steel – refractory interface

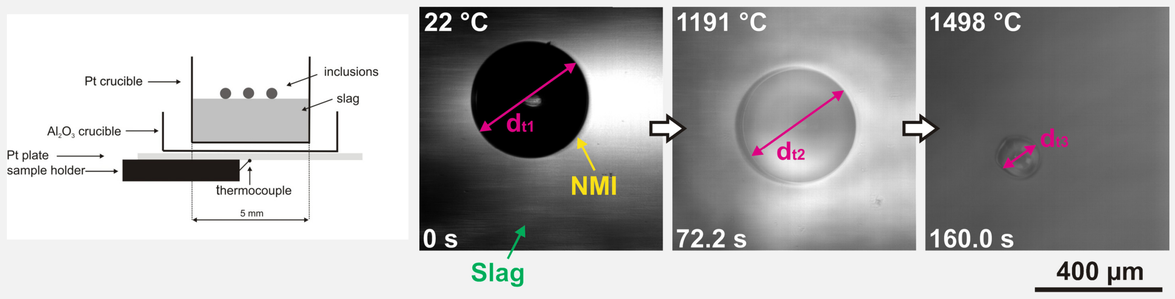


There are three main research topics concerning the investigation of NMI by HT-LSCM:

(1) Inclusion nucleation, growth and agglomeration in steel



(2) Inclusion dissolution in slag



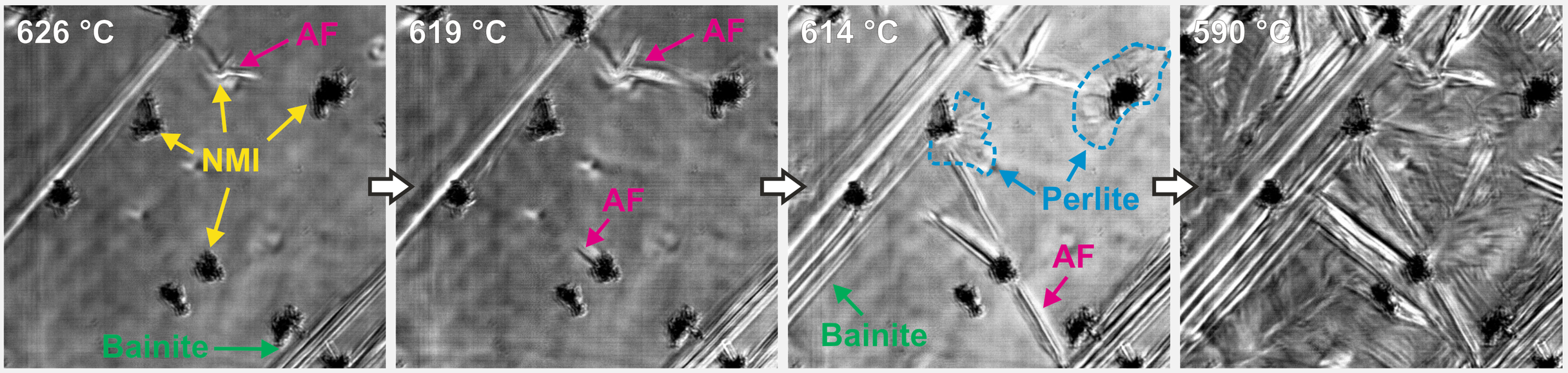
(3) Influence of non-metallic inclusions on the microstructure

Heterogeneous nucleation sites during phase transformations, pinning during austenite grain growth and grain refinement.

Sources: Bernhard, C. et al., BHM 156 (2011), 5, 161-167. Michelic, S.K. et al., AISTech 2013, presentation.

Acicular Ferrite & HT-LSCM

Due to the possibility of an accurate adjustment of austenitizing temperature and the well controllable cooling conditions high-temperature laser scanning confocal microscopy (HT-LSCM) is a perfect tool for the investigation of the acicular ferrite (AF) formation and the interaction of steel composition, cooling rate, austenite grain size and microstructure. By using a HT-LSCM for the in situ observation of austenite – ferrite transition in HSLA steels, fundamental information about the formation mechanisms of AF can be gained.



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