MM 55: Topical Session Modern Atom Probe Tomography V - Steels, Alloys and Structural Materials

Time: Thursday 15:45–17:00 Location: H 0107

MM 55.1 Thu 15:45 H 0107

Characterisation by Atom Probe Tomography of a Precipitation Hardened Lean Maraging-TRIP Steel — •Julio Millán, Dirk Ponge, Pyuck-Pa Choi, and Dierk Raabe — Max-Planck Institut für Eisenforschung, Max-Planck-Str. 1, 40237 Düsseldorf, Germany

Nano-scaled microstructural changes generated in two as-quenched multicomponent alloy systems Fe-xMn-2Ni-1Mo-1Ti-0.15Al-0.01C (x=9 and 12, mass%) during aging at 450°C for 48 hours were evaluated by atom probe tomography. After the solution treatment and subsequent quenching, an initial microstructure consisting of a fully martensite matrix or a mixture of retained austenite and martensite were obtained in the 9%Mn and 12%Mn alloy, respectively. Upon aging, precipitation of nano-sized particles and simultaneous formation of reverted austenite occurred in both materials. No differences in the chemistry of the particles core were found when the nominal Mn content in the alloy was increased from 9 to 12%. However, a difference in formation and growth of the reverted austenite was observed depending on the presence of retained austenite in the quenched state. In absence of retained austenite (9%Mn alloy), the accumulation of Mn together with other alloying elements was detected at the internal interfaces of the martensite matrix, suggesting the formation of a metastable thin-film of reverted austenite. In contrast, the 12% Mn alloy exhibited an accelerated formation of reverted austenite occurring not only at the martensite-martensite interfaces but also around the retained austenite.

MM 55.2 Thu 16:00 H 0107

Analysis of the carbon distribution in a dual phase steel by EBSD and APT — •Lars Schemmann and Stefan Zaefferer — Max-Planck-Institut für Eisenforschung GmbH

Dual phase steels have been invented in the late seventies and early eighties. They combine good mechanical properties, such as a high strength and good formability. Even though they are produced at present time routinely by all big steel companies, some fundamental properties are not perfectly understood. This study focuses on the distribution of carbon in the steel, whereby the gradients at the ferrite martensite border are of special interest. On a microscopic level a combination of EBSD and EDX is used to identify areas of interest. These areas are subsequently analyzed using atomic resolution APT.

MM 55.3 Thu 16:15 H 0107

Atom probe studies on nano-sized precipitates in lightweight steels — •Jaebok Seol[1], Changyung Park[2], Pyuckpa Choi[1], and Dierk Raabe[1] — [1]Max-Planck-Insititut für Eisenforschung, Dusseldorf, Germany — [2]Dept. of Materials Science and Engineering, Pohang University of Science and Technology (POSTECH), Republic of Korea

Recently, light-weighted steels containing a low Mn of 3 wt.% and a high Al of 6 wt.% have received considerable attention as a new grade of advanced high strength sheet steels (AHSS) due to their excellent combination of strength and ductility.. The mechanical properties of the steel depend on the precipitation of nano-sized (Fe,Mn)3AlC, κ-carbide particles. However, the decomposition of metastable γ (austenite) into α (ferrite) and κ-carbide as a function of isothermal temperatures has not been studied in detail, in particular at the atomic scale. In this work, phase transformation and elemental redistribution within Fe-Mn-Al-C alloys have been studied by electron back-scatter diffraction (EBSD), X-ray diffraction (XRD), scanning transmission electron microscopy (STEM), and atom probe tomography (APT) in conjunction with thermodynamic descriptions. We observe that as austempering temperature increases, the volume fraction of retained γ decreases with increasing the κ-carbide fraction. In addition, APT results reveal the distribution behaviour of alloying elements in the vicinity of α/carbide interfaces. Based on these observations, we evaluate the correlation between the stability of κ-carbide and isothermal temperature.

MM 55.4 Thu 16:30 H 0107

Atom probe tomography analysis of Sr-modified Al-Si hypoeutectic alloy — •Jenifer Barrirero, Michael Engstler, Hisham Aboulfadl, and Frank Mücklich — Functional Materials, Department of Materials Science, Saarland University, D-66123 Saarbrücken, Germany

Al-Si casting alloys are of great industrial importance. The addition of traces of Sr, causes a flake-to-fibrous transition which contributes to the improvement of tensile, impact and thermal shock properties. In order to obtain a better understanding of the underlying mechanisms occurring during this modification, an analysis of Sr distribution was done by laser pulsed atom probe tomography. Site-specific sample preparation of unmodified and modified (150 ppm Sr) hypoeutectic AlSi7 alloy was accomplished by focused ion beam methods. The concentration of Sr at the eutectic Al-Si boundary and its distribution in the eutectic Si were analysed. The results revealed nanometric segregations in the eutectic Si with two to three times more Al than Sr. These features showed linear and planar morphologies which are, to some extent, in agreement with the fundamentals of the impurity induced twinning theory for modification. A morphological comparison between the eutectic Al-Si boundary of modified and unmodified alloys showed a change in the growth front of the eutectic phase as proposed by early theories. The unmodified alloy presented an inhomogeneous jagged boundary in accordance with an endogenous type of growth, while modified specimens had a smoother boundary morphology possibly related to a retarded growth rate of Si.

MM 55.5 Thu 16:45 H 0107

Sr distribution in modified hypoeutectic Al-10Si alloy — •Melanie Timpel[1], Nelia Wanderka[1], Ralf Schlesiger[2], Tomokazu Yamamoto[3], Nikolai Lazarev[4], Dieter Isheim[5], Guido Schmitz[2], Syo Matsumura[3], and John Banhart[1] — [1]Helmholtz-Zentrum Berlin, Berlin, GER — [2]Institut für Materialphysik, Westf. Wilhelms-Universität, Münster, GER — [3]Kyushu University, Fukuoka, JPN — [4]Kharkov Institute of Physics and Technology, Kharkov, UKR — [5]Dep. of Materials Science and Engineering, Northwestern University, Evanston, USA

Small additions of Sr ($\geq$ 200 ppm) to Al-10Si alloy drastically change the morphology of eutectic Si from large plate-like to fine fibrous ('chemical modification'). To understand the mechanisms of modified Si growth the local distribution of Sr in eutectic Si phase has to be clarified. In this study, three-dimensional atom probe tomography and high resolution transmission electron microscopy were applied to locate Sr within the eutectic Si phase. The results of combined investigations indicate local enrichment of Sr (4 at.%) in combination with Al at specific sites of the faceted Si crystal. Linear SrAlSi segregations with tube-like morphology and average width of 4 nm were found at the origin of Si {111} twins, whereas planar SrAlSi segregations with 8×4 nm^2 and length up to 220 nm were found at internal boundaries of eutectic Si. Here we show our results and discuss them with respect to previously postulated modification mechanisms.