M5-8 Application of New Microscopic Methods for Analyses of Multiphase Steels

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TRIP steels belong to a group of new perspective materials, which show high strength as well as good ductility. This combination of properties can only be achieved along with a suitable structure by means of heat or thermomechanical treatment. Optimal structure would consist of ferrite, bainite and retained austenite (RA). At the same time suitable fractions of individual phases and their morphology play an important role. RA is a very important component of the structure, which requires colour etching so that it can be distinguished from ferrite using light microscopy. For detailed analyses like determination of retained austenite morphology and carbide distribution, electron scanning and transmission microscopy must be used. Moreover, the so-called MA component, which denotes a very weak relief of martensite, can appear in the islands of retained austenite. Many of these issues can be solved by utilizing laser confocal microscopy.

A new laser confocal microscope (LCM) OLYMPUS LEXT OLS-3000 USS has been introduced recently. This microscope allows observation in the light mode up to a magnification of 2400x and in the confocal laser mode up to 14400x. A great advantage is the fact that no special specimen preparation and no special observation conditions are necessary. This microscope proved to be very suitable for analyses of the aforementioned very complicated and complex structures.

This paper deals with a comparison of various methods of microscopic observation. In the first instance the specimens were observed using light microscopy at different magnifications. After applying the standard etching agent, it was impossible to distinguish ferrite from the RA islands, which made the image analysis unusable. Therefore, two-step etching was applied to emphasize the RA, which remained white while ferrite became brown (Fig. 1).

An electron scanning microscope was used to determine individual details in the structure, and the morphology of RA was observed at a magnification of about 5000x. For a detailed description of carbide distribution in the laths of bainitic ferrite it was necessary to use carbon replicas (Fig. 2). With both methods the presence of martensite in the islands of RA can be detected.

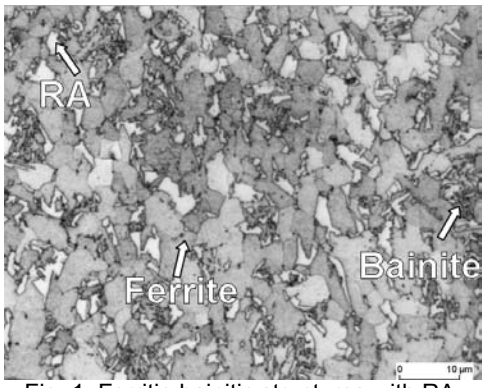

Fig. 1: Ferritic-bainitic structures with RA, light microscopy, two step etching: Nital + 10%$Na_2S_2O_5$

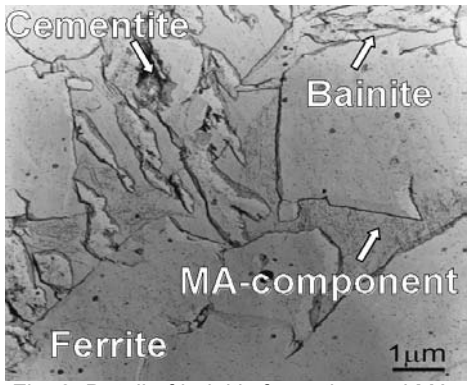

Fig. 2: Detail of bainitic formation and MA-component, transmission microscopy, Nital

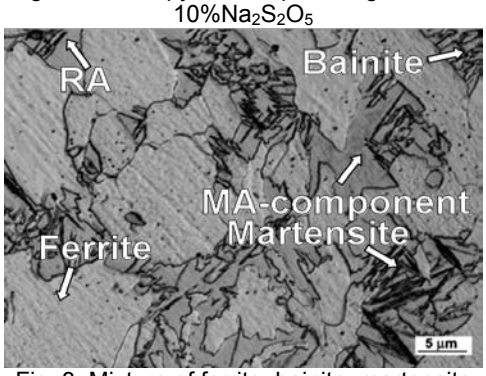

Fig. 3: Mixture of ferrite, bainite, martensite and RA, laser confocal microscopy, Nital

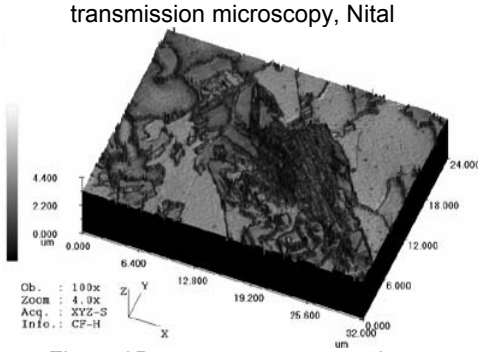

Fig. 4: 3D structure reconstruction, complex four phase structure, confocal laser microscopy

The LCM was employed for comparison. Magnification of up to 14400x was tested in the confocal mode for observation of a complex four phase structure consisting of ferrite, bainite, RA and needles of temperature induced martensite (Fig. 3). The RA islands contained a significant MA component as well. Furthermore, 3D structure reconstruction can be used to emphasize the relief of individual components. As an example, a formation of martensitic needles surrounded by ferritic grains with RA islands is shown in Fig. 4. The height relief allows individual components to be distinguished based on the intensity and depth of etching. At present, new methods of specimen preparation are being developed, which will lead to intensive distinction of structure components, in order to further improve the utilization of the relief reconstruction principle offered by LCM.

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