RECENT APPLICATIONS OF APFIM ON VARIOUS STEELS

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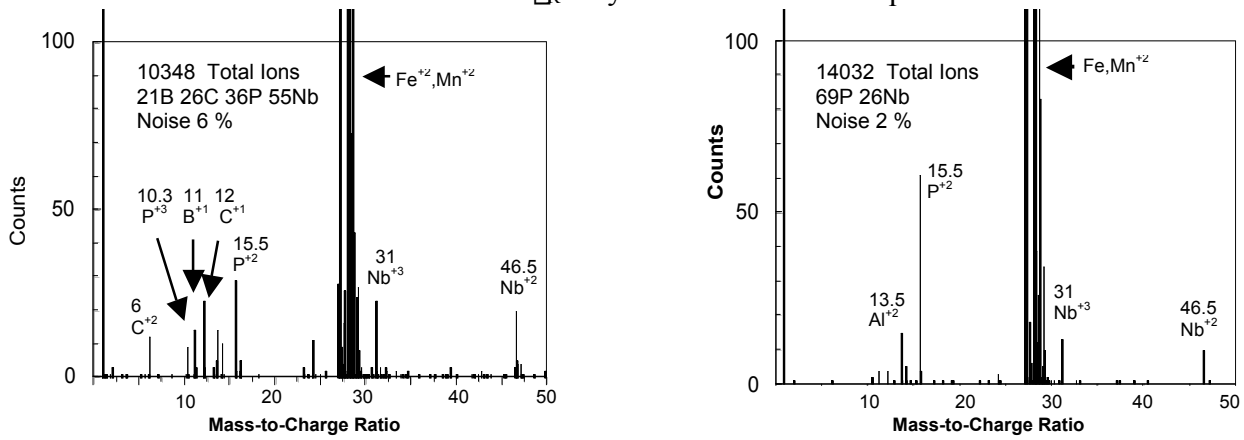
A substantial amount of the R&D being conducted at the Basic Metals Processing Research Institute is related to grain boundary engineering and its effects on enhancing the performance of materials. This paper will present some examples in which the use of APFIM has been essential in the understanding of the composition of grain boundaries.

The first example is from the development of a non-leaded, free machining steel (12T14). APFIM analysis on the hot-rolled 12T14 material revealed that atomic Sn is present as a multi-layer on the boundaries. The segregation of Sn at the ferrite grain boundaries lowers their cohesive strength, hence facilitating fracture. The significance of this phenomenon is that by lowering the fracture resistance of the grain boundaries, the machinability of the steel is improved.

Progress is also made in studying the grain boundary segregation of P, Nb, B and C in ultra-low carbon (ULC) steels. After coiling at high temperature (700°C), Nb is found to be as effective as B in segregating to ferrite grain boundaries, thus improving the resistance to cold work embrittlement (CWE) of Ti+Nb+P ULC steel. The extent of the grain boundary region for P segregation is narrower than that for C. The assignment of the peak at 31 u ($^{93}Nb^{3+}/^{31}P^{+}$) will be discussed (see Figures). It is also noted that when P is added to ULC steel, the ferrite matrix may no longer be "interstitial-free", i.e., solute C may become available, leading to yield point elongation.

The third example is on a TRansformation Induced Plasticity (TRIP) steel, where controlling the volume fraction and distribution of retained austenite (γ_R) is important in achieving high strength. APFIM revealed that the C concentration in γ_R may be well below the equilibrium value.



Left - APFIM mass spectrum containing a GB section in Nb+P ULC steel with Tcoil = 700°C. Most of the solutes, C, P, Nb, and B, were collected from GB region. (Here, B is due to residual content). Right - Tcoil = 600°C, no C or B were collected from this GB.

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