

8306-072

RECENT INNOVATIONS IN ALLOY DESIGN AND PROCESSING OF MICROALLOYED STEELS

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ABSTRACT

The present review describes some of the principal developments with regard to alloy chemistry and processing technology of microalloyed steels which have been made within the past ten years. The progress during this period has been coloured by advances in steel production - improved control over residuals, continuous casting, rapid cooling technology etc., as well as by more stringent specifications and user demands - enhanced weldability formability and machinability, more cost effective alloying, minimization of heat treatment and so on. Concerning alloy design, attention is focussed on the following: microalloying with Ti, boron in ultra low-carbon (bainitic) steels and in heat-treatable steels, vanadium-nitrogen grades, and various developments of engineering steels (e.g. microalloying for hardenability in QT-steels, ferrite-pearlite forging grades, cold-finished bars etc). As regards the developments in processing technology for microalloyed steels, consideration is given to controlled cooling of plate, recrystallization hot rolling, direct quenching and controlled cooling in association with forging for elimination of subsequent heat treatment, and to the application of thermo-mechanical treatment in the production of bars and profiles.

THE DEVELOPMENT OF THE IMPRESSIVE properties profile characterizing modern high-strength low-alloy steels must be regarded as one of the most significant metallurgical advances over the last two decades. An good appreciation of the then current level of knowledge in this area can be gleaned from "Microalloying '75"(1). The aim of

the present review is to summarize the major advances as regards both alloying chemistry and processing technology of microalloyed steels which have been made during the period since that publication. It is taken for granted that the reader is familiar with the basic concepts governing the relationships between chemistry, microstructure and mechanical properties of carbon and low-alloy steels. Excellent reviews on this subject are given in Microalloying '75 (2,3); the book by Leslie (4) is also to be recommended. Furthermore, it is not the intention to dwell in any detail on the considerable recent advances which have been made in understanding the role played by various microadditions during the thermo-mechanical processing of austenite; the current standing on this topic is covered admirably by the proceedings of the Pittsburgh conference (5) and by a number of overview articles, e.g. (6,7). Finally, attention is to be restricted to microalloy technology as applied to hot-rolled and heat-treated products (plate, sheet, bar, forgings). No consideration will be given to the alloy design and processing concepts relevant to the production of cold-rolled and annealed sheet.

The progress as regards the technology of both alloying and processing microalloyed steels over the past decade, has been coloured to a greater or lesser extent by the following factors:

- i) New steelmaking procedures, for example, combination blowing of converters and ladle-treatment techniques. These methods permit the attainment of low impurity levels (O,S,N,H,P) and even low carbon contents; microalloyed HSLA-steels produced using such techniques can exhibit a range of interesting and attractive properties.
- ii) The widespread transition from ingot- to continuous-casting technology. Because of the