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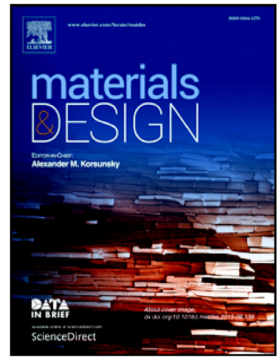

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Intricate morphologies of laths and blocks in low-carbon martensitic steels

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Abstract

Low-carbon martensitic steels are made of intricate assemblies of martensitic laths: the twenty-four lath variants are grouped into packets on the four $\{111\}_{fcc}$ planes, and each packet is composed of three blocks of pairs of low-misoriented variants. The orientation relationship between the laths and their parent austenitic grains ranges from Kurdjumov-Sachs toward Nishiyama-Wassermann. The paper presents electron microscopy investigations that confirm that the habit planes of the laths are the {557} planes that contain the common fcc-bcc dense directions. The morphology of many blocks appears as a bifoliate structure made of the habit planes of the two low-misoriented lath variants they contain. A theoretical model is proposed to discuss the results. The average of the two Kurdjumov-Sachs distortions associated with the variants in a block is a Nishiyama-Wassermann distortion. The {557} lath plane of each of the two variants in a block is untilted by the Nishiyama-Wassermann distortion of one of the two neighboring blocks in the packet. Complete self-accommodation is also obtained in individual packets. These results could explain simultaneously the {557} lath planes and the lath/block intricacy in the packets.

Keywords:

Steels; Martensitic transformation; Habit plane; Distortion matrix; TEM; EBSD

1. Introduction

1.1. Morphologies of the laths and blocks

Low-carbon steels and iron nickel alloys containing less than 28 wt-% Ni exhibit after quenching microstructures constituted of body centered cubic (bcc, α) lath martensite. An extensive review of their microstructures and properties was recently published by Krauss [1]. The mean orientation relationship (OR) of martensite with its parent face centered cubic (fcc, γ) austenite is close to Nishiyama-Wasserman (NW) [2][1][3], or in-between NW and Kurdjumov-Sachs (KS) [4], i.e. close to Kelly [5] or Greninger-Troiano (GT) [6]. The study of martensitic laths by optical microscopy is difficult because of their fine and highly intricate structures, and because in most of the low-carbon steels the martensitic transformation is complete and there is no retained austenite. Despite these difficulties, Marder and Krauss [7] elegantly took advantage that the long straight lines visible in metallography are twin boundaries of prior parent austenitic grains to calculate their orientations and statistically determine the habit planes of martensite in the austenite reference frame; and they