

ON THE NUCLEATION OF MARTENSITE IN NONSTOICHIOMETRIC.
Ni_{1+x}Mn_{1-x} ALLOY*

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In this note a novel conceptual approach to martensite nucleation is presented. The proposed model is based on the microstructural characteristics of the low temperature tetragonal martensite which has been observed in Ni-rich Ni-Mn alloy¹.

In Fig.1 the complex martensite is shown as seen approximately along the [111] directions. The planes between parallel plates and the micro-twin interfaces in a particular plate are parallel to the [111] direction. The formation of this micro-structure can be explained as being due to the composite transition² from the disordered f.c. cubic structure to the "ordered" twinned f.c. tetragonal one. In the premartensitic stage the "ordering" reaction takes place. This reaction is accompanied/ followed by antiferromagnetic ordering of spins, which is responsible for the tetragonal distortion of the cubic lattice³. The strain energy associated with this distortions can be minimized by the formation of different crystallographically equivalent variants of the long range lattice fluctuations (static waves). These fluctuations tend to change the cubic structure into the twinned tetragonal one (premartensitic twins) with the twinning planes along the crests of the waves (Fig.2a). Particularly interesting is the distribution of the tetragonal distortions in the regions where two waves interfere (Fig.2a). It is assumed that at some critical temperature the elastic strains associated with these distortions trigger the lattice invariant deformations of the martensitic transition. Within such localized region, which can be considered, henceforth as an embryo of the martensite, the transition realizes via three noncoplanar twinning shears of $\{110\} \langle 110 \rangle$ type (Fig.2b). Outside the embryo, i.e. along the crests of an interlocking wave, the martensitic reaction extends by the operation of only two twinning shears. This twinning (the martensitic twinning) occurs with a ratio of 2:1 between the twin components and it compensates nearly completely for the strains induced in the premartensitic stage⁴.

The proposed model is, however, not limited to the magnetic fluctuations, as shown in this note, but could be applied with any other heterogeneity, such as for example, the compositional fluctuations or static lattice waves which distort the original lattice towards the spatial arrangements of the new structure⁵. Besides, it could be easily recognized that the three noncoplanar twinning shears revealed in the present case represent a group of lattice invariant shears — which are not necessarily the twinning shears — operating during formation of the so-called self-accommodating martensites^{6,7}.

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*This work is going to be presented at the Int.Conf."Martensitic Transformations", ICOMAT-77, May 1977, Kiev, USSR.



Fig. 1

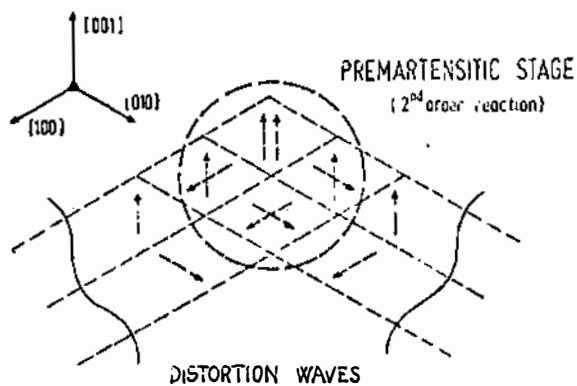


Fig. 2a

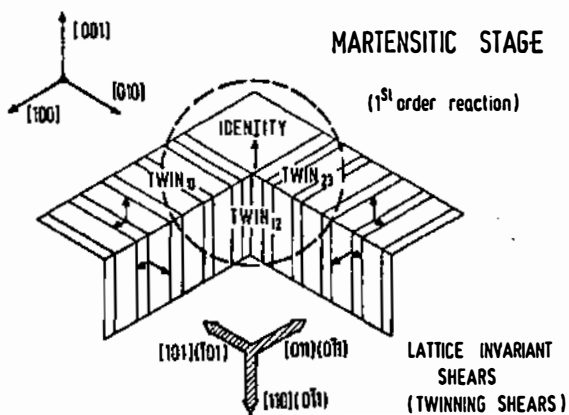


Fig. 2b