

LETTERS TO THE EDITOR

Comments on the paper "Electron Microscope Observation of the Austenite and the Martensite in High Aluminum Steel (Supplement)"

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In a recent study of "extra" diffraction spots found by electron diffraction from retained austenite in quenched high-aluminum steels, Tadaki, Shimizu and Watanabe concluded that such reflections arise because of the Cu_3Au -type ordered nature of the austenite⁽¹⁾. Alternatively, Oshima and Wayman observed that the fundamental reflections from austenite in a quenched Fe-7%Al-2%C steel were split into two spots, and the extra spots were attributed to a fine perovskite-type κ -carbide which forms epitaxially in the austenite during quenching⁽²⁾. More recently, Tadaki and Shimizu carried out supplementary experiments in a further attempt to elucidate which of the above two explanations might be more tenable⁽³⁾. They too found the existence of the κ -carbide, but from other evidence they obtained reiterated that the quenched austenite is essentially a Cu_3Au superlattice. In the following discussion, we intend to provide evidence contrary to their explanation. However, in the final analysis, it seems most important to emphasize that Tadaki and Shimizu studied an Fe-9.70wt%Al-1.46 wt%C alloy whereas both our earlier and supplemental work has dealt with an Fe-7.0 wt%Al-2.0wt%C alloy. Thus, different phenomena may occur in such disparate alloys and consequently any direct comparison between the two may not be meaningful.

As mentioned in our previous paper⁽²⁾ Al shrinks the γ -loop in the binary Fe-Al system, while the addition of carbon (i.e., Fe-Al-C) considerably extends it. This indicates that carbon atoms play an important role in the stabilization of the austenite in the Fe-Al-C system, and in turn suggests that the effect of the carbon atoms cannot be neglected when describing the γ -phase in the Fe-Al system, i.e.,

the Fe-Al-C system must be considered. So rather than considering a Cu_3Au -type superlattice (noting the carbon content involved) it appears more appropriate to envision a ternary superlattice. Such a structure corresponds to the perovskite structure previously proposed⁽²⁾.

The quenched specimens we have observed are ferromagnetic. In this connection it is interesting to note that many interstitial compounds having the perovskite structure have been reported to be ferromagnetic, e.g., Fe_4N , Mn_4N , Fe_3PtN , Fe_3NiN , Mn_3AlC , Mn_3ZnC , Mn_3SnC , etc. In these compounds the interstitial C or N atoms occupy the body-centered site and provide electrons for the face-centered atoms (e.g., Fe or Mn) for bonding. This situation may well apply to the Fe_3AlC case.

In their recent report⁽³⁾ Tadaki and Shimizu show that the fundamental spots do not consist of two spots, but rather a main spot with four satellite reflections. They emphasized the importance of very short exposure times to resolve the different spots. With this in mind, we have re-examined the diffraction spots from austenite in Fe-7Al-2C with particular care to avoid overexposure and the subsequent loss of details. As shown in Photo. 1, for example, each fundamental spot consists of a doublet as reported before, and not a main spot surrounded by four satellites. Thus, there is an intrinsic difference considering the two materials involved. Possibly, the weak satellite reflections observed by Tadaki and Shimizu might be attributed to a magnetic deflection effect. It is not possible to pursue this point at present because magnetic data for the *fcc* Fe_3Al structure are unavailable. However by extending results already known for *fcc* Fe-Mn alloys, it appears reasonable that *fcc* Fe-Al

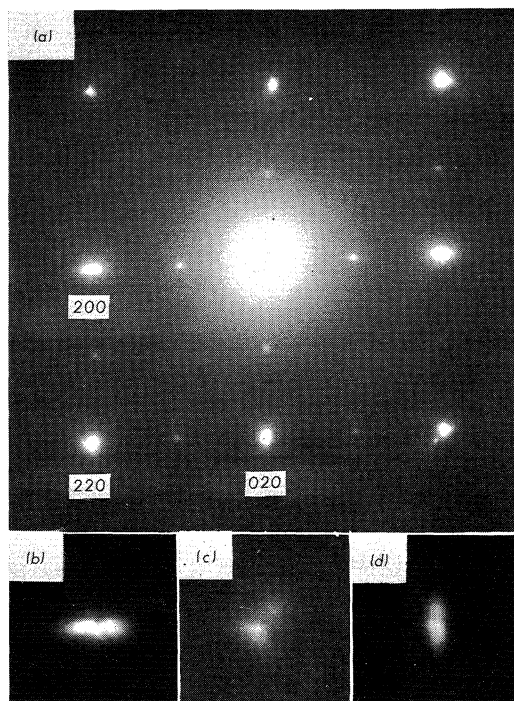


Photo. 1 Electron diffraction pattern from retained austenite, showing [001] zone (a), and fine structure of 200 spot (b), 220 spot (c) and 020 spot (d).

alloys are not ferromagnetic.

As suggested in our previous paper⁽²⁾ the observed, fine κ -carbide particles result from a spinodal decomposition during quenching. Accordingly, in the process of spinodal decomposition the product phase (precipitate) does not necessarily have a distinct stoichiometric composition, but rather a wide distribution. Thus, the lattice parameter we observed need not necessarily correspond to that of the κ -phase ($3.74\text{--}3.78\text{\AA}$)⁽⁴⁾. Actually, we noted that the separation of the doublet is highly dependent on the quenching rate. When using a "slower" quench from a horizontal furnace (compared to a vertical furnace) the doublet separation became larger and the appearance of the additional spots was more distinct. In addition, higher M_s temperatures were obtained during the slower quenches. However, if the

matrix is ordered, which would seem to be more so the case during slower quenches (by comparison with results obtained for Fe_3Pt) one would expect a decrease in the M_s temperature and not an increase. But, if during the slower quenches a carbide nucleates and grows to a certain extent, then the Al and C contents of the matrix will decrease, which will result in a rise in the M_s temperature as observed.

As seen in Photo. 1 of Tadaki and Shimizu's paper⁽³⁾ the retained γ -region exhibits a mottled image contrast which differs from that found in the large κ -particles also seen. This is explicable by reference to the Fe-Al-C ternary diagram⁽⁵⁾: even after the κ -phase forms by ordinary precipitation, additional particles could form during the quench because of the wide κ -region.

The above arguments thus serve to question the existence of a Cu_3Au -type superlattice in the Fe-7Al-2C alloy.

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