Probing the effect of intragranular premature κ-carbide precipitation on incipient plasticity behavior in austenite-based Fe-Mn-Al-(Cr)-C steels

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This work investigated the effect of nanoscale intragranular premature κ-carbide precipitation on incipient plasticity behavior of austenite in the Fe-20Mn-9Al-(0, 3, 6 and 9) Cr-1.2C (wt.%) low-density steels processed by near-rapid solidification. We found that, different from the well-known coarsened κ-carbides, all the formed premature κ-carbides were proven to have an ordered $L'1_2$ structure but no chemical partitioning at near-atomic scale. The incipient plasticity of all the studied samples (with and without premature κ-carbides) was dominated by the heterogeneous dislocation nucleation mechanism via atom-vacancy exchange. Although the increase of Cr content effectively suppressed the precipitation of premature κ-carbides, it seemed to have negligible effects on incipient plasticity strength due to the increased shear stress for dislocation nucleation. Comparatively, the increased content of interstitial C atoms with the Cr content in austenite enhanced lattice cohesions to impede nucleation events by increasing necessary shear stress for dislocation nucleation.

Keywords: Fe-Mn-Al-C low-density steel, Premature κ-carbide, Dislocation nucleation, Nanoindentation, Charge transfer.

References:

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