Atomic resolution investigations of phase transformation from TaN to CrTaN in a steel matrix - DTU Orbit (16/01/2019)

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In development of 12%Cr high temperature steels used for fossil fired power plants, the precipitation of large Z-phase particles, CrMN, has been identified as a major problem since they replace small and finely distributed MN particles. This causes a premature breakdown in the long term creep strength of the steel. The Cr content promotes Z-phase precipitation, making MN strengthening of these materials unfeasible, since 12%Cr is necessary for oxidation resistance. The authors have suggested an acceleration of Z-phase precipitation to obtain a fine and stable distribution of CrMN instead of MN, thus preserving long-term creep strength. This can be done by alloying with Ta instead of Nb and V. Recent investigations have indicated a direct transformation of MN into CrMN to take place, not the traditional nucleation/dissolution process. In this paper atomic resolution microscopy shows how Cr atoms diffuse from the steel matrix into TaN precipitates and physically transform them into CrTaN. The crystal structure of the precipitates changes from that of a typical MN NaCl type crystal structure to a Z-phase crystal structure with alternating double layers of Cr and TaN. Since there is a large contrast between heavy Ta atoms and light Cr atoms, the ordering of the Cr layers inside the TaN particles can clearly be observed.

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