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Recrystallization kinetics of Fe-30Ni alloy with 0.008-0.083% Nb

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Niobium is added to many steel grades as a 'microalloying element' in small quantities of around 0.05% for significantly improving their user properties of strength and toughness by refinement of the final grain structure. This is notably the case in high strength low alloy (HSLA) steels which are processed by low temperature controlled rolling. The intention is to produce a deformed grain structure in the austenite with a high density of grain boundaries where ferrite grain nucleation can take place during quenching. Niobium plays a vital role since it retards recrystallization of the austenite and raises the recrystallization temperature. Despite many investigations into this phenomenon, it is far from clear how this mechanism operates and how to optimize it.

The GLUS® testbed at Swerim which is the combination of the thermo-mechanical simulator GLEEBLE and laser ultrasonics (LUS) provides a unique possibility to explore and validate alloying concepts to increase the understanding of how material properties evolve during the process. Especially the GLUS® technique is useful for the materials where the prior austenite grain is impossible to reconstruct. We will present results of model alloys similar to that of Ji et al [1] with various amount of Nb that has been evaluated in order to increase the understanding of the influence of Nb on the recrystallization behavior. The model alloys were soaked for 3 min at 1100 °C after which they were deformed at 850, 900, or 950 °C with two hits with an engineering strain of 20 % each. Below in Fig. 1 the measured longitudinal wave velocity of one of the model alloys shown as a function of temperature, which displays a parabolic shape due to the particular thermo-elastic behavior of Ni. The measured grain size as a function of time post compression is also shown in Fig. 1 for the two hits of the 0.083 % Nb at 950 °C which displays 50% the recrystallization at around 4 seconds post compression.

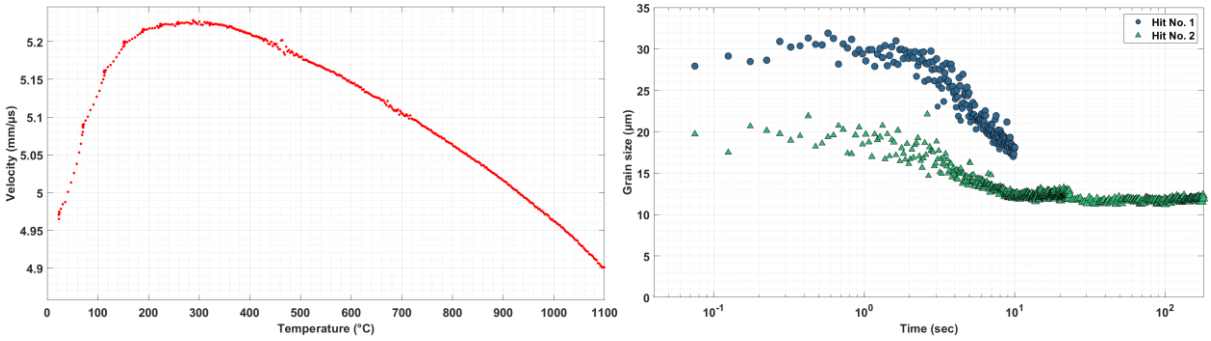

Fig. 1 (left) P-wave velocity versus temperature during heating for the Ni 30 % model alloy with Nb 330 ppm. (right) The measured grain size vs time post compression of 20 % + 20 % (engineering strain), with a speed of 10 ps and an inter-pass-time of 10 seconds between the two hits.

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[1] Ji M, Janik V, Strangwood M, Davis C. Effect of grain size distribution on recrystallisation kinetics in a fe-30ni model alloy. Proceedings of the 6th International Conference on Recrystallization and Grain Growth, 2016, p. 6.