8th International Conference on Physical and Numerical Simulation of Materials Processing (ICPNS)

14–17 October 2016

Seattle, Washington | Hosted by Purdue University

SESSION 5: IRON AND STEEL, HARBOR HALL

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SATURDAY, OCTOBER 15, 2016

Mechanical properties of stainless steels with heterogeneous nanostructures

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ABSTRACT

Stainless steels, SUS316LN and SUS329J3L, were heavily cold rolled to 92%. Hetero-nanostructure, composed of lamellar, deformation twins, and shear bands, was homogeneously developed. The all above component micro-structures were much less than 100 nm. The as-cold rolled samples exhibited high tensile strength over 1.5 GPa with ductility approximately 10%. These specific mechanical properties were almost comparable with those of ultrafine grained (UFGed) 316L stainless steel fabricated by multi-directional forging. The UFGed structure and specific mechanical properties were, therefore, simply achieved by cold rolling without severe plastic deformation. When the cold-rolled samples were aged, tensile strength was more drastically increased. Tensile strength over 2.6 GPa with ductility about 5% was achieved, even while it exhibited anisotropy in the mechanical property. The observed notable mechanical properties would be caused by the heterogeneous nano-structures, where dense distribution of nano-twins nano-shear bands as well as nano lamellar contributed to impede early rupture to derive superior balance of strength and ductility.

KEYWORDS: ultrafine grain, twin, shear band, mechanical properties, stainless steel, lamellar, cold rolling