POLITECHNIKA ŚLĄSKA

Wydział Mechaniczny Technologiczny

mgr inż. Gabriela FOJT-DYMARA

PRACA DOKTORSKA

Strukturalne i mechaniczne czynniki ciągliwości na gorąco stali wysokomanganowych

PROMOTOR
dr hab. inż. Marek OPIELA, prof. PŚ

GLIWICE 2022

ABSTRACT

Structural and mechanical factors of the hot ductility of high-manganese steels

The doctor's thesis is an attempt to explain the structural and mechanical factors influencing the hot ductility of high-manganese steels.

In the literature part of the work, the basic mechanisms of the strengthening of iron alloys are described, the steels of the TRIP, TWIP and TRIPLEX type are characterized, as well as the cracking mechanisms of polycrystalline materials.

The adopted thesis assumed that the synergistic effect of appropriately modified non-metallic inclusions, fine-grained structure of dynamically recrystallized austenite and the micro-additive Ti limiting the occurrence of harmful AlN and MnS-AlN inclusions, would improve hot ductility of high-manganese steel. The thesis was verified on the basis of the adopted comprehensive research program, including the influence of temperature and plastic deformation rate on the structure and mechanical properties of tested high-manganese steels.

The tests of the 27Mn-4Si-2Al-Nb type steel and the 24Mn-3Si-1.5Al-Nb-Ti type steel were divided into two stages. In the first one, the analysis of the degree of contamination of steel with non-metallic inclusions was carried out, and the influence of the solution heat treatment temperature on the austenite grain size and mechanical properties was investigated. The second step, to d termine the hot ductility, involved high-temperature tensile and compression tests (SICO test) with the Gleeble 3800 thermomechanical simulator.

The conducted high-temperature tensile and compression tests allowed for: determination of flow curves, evaluation of hot ductility based on the reduction in area, examination of the structure, determination of the nil strength temperature, nil ductility temperature, ductility recovery temperature and the high-temperature brittleness range, as well as the influence of the temperature and strain rate on the value of the circumferential deformation of the sample at which the crack occurred.

The conducted tests showed that the 24Mn-3Si-1.5Al-Nb-Ti type steel had significantly higher hot ductility in the entire temperature range tested. Both types of steels showed a relatively narrow range of high-temperature brittleness, amounting to 30 °C, while the high-temperature brittleness range of the 24Mn-3Si-1.5Al-Nb-Ti type steel is displaced relative to the 27Mn-4Si-2Al-Nb type steel to a higher temperature range.

The obtained test results make it possible to develop the conditions for hot forming of sheets from the developed high-manganese steels with high mechanical properties and guaranteed hot ductility.