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ROLE OF ALLOYING ELEMENTS IN THE FORMATION OF MECHANICAL PROPERTIES OF AISI 316LN STEEL IRRADIATED WITH NEUTRONS

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Austenitic stainless steels are widely used as structural materials in nuclear power engineering, as well as in many other non-nuclear engineering and technological fields. This is due to their good mechanical properties as well as fairly high corrosion and radiation resistance. Recently, much research has focused on nitrogen-containing grades of steels, such as AISI 304 LN. The advantages of nitrogen alloying are stabilization of the austenitic matrix, increased strength of the material, improved corrosion resistance and reduced nickel content in the steel. It is worth considering that neutron irradiation, in particular of austenitic stainless steels, affects the microstructure and mechanical properties of materials. Low temperature irradiation of austenitic stainless steels lead to increase in yield strength and a decrease in plasticity, which is the result of clustering of point defects, particularly dislocation loops. In this work, changes in mechanical properties and microhardness of austenitic stainless steel grades based on AISI 316LN after neutron irradiation in the WWR-K reactor are investigated.

AISI 304 and AISI 316LN austenitic steels were selected as objects of study. 211 L, 212 L and 213 L were produced from AISI 316LN by alloying with nitrogen, manganese, copper and tungsten.. An austenitizing annealing at 1050 ℃ for 30 min in a vacuum tube (1 Pa) was carried out. In December 2023, irradiation of the samples of the investigated steels was carried out in the WWR-K reactor (Almaty, Republic of Kazakhstan). The samples were irradiated to fluence of Φt = 3.18×1018 n/cm^2. Mechanical tensile tests were performed at room temperature using INSTRON 1195 universal testing machine at a constant strain rate of 0.5 mm/min. Vickers microhardness values of irradiated and unirradiated specimens were measured using a Micro Vicker Hardness Tester at a load of 100g.

As a result of experiments, it was found that: the values of total and uniform elongation of steel AISI 304 are the highest among the studied steels, due to the γ⟶α transformation. Alloying with nitrogen (N) manganese (Mn) and molybdenum (Mo) reduces plasticity by suppressing the γ⟶α transformation. Steel 213 L alloyed with tungsten (W) has the highest value of microhardness and the tensile strength of this steel is comparable to that of AISI 304 steel. From this it can be concluded that alloying with nitrogen and tungsten compensates for the loss of strength caused by the suppression of the γ⟶α transformation. The elongation values, both uniform and total elongation, decreased for all steels after neutron irradiation, except for that of AISI 304 alloy. After irradiation, the microhardness of all the steels studied increased, while the yield strength increased most significantly for 212 L and 213 L steels.

Primary author: BOBRUSSOVA, Yuliya (Institute of Nuclear Physics Kazakstan)

Co-authors: MEREZHKO, Diana (Institute of Nuclear Physics); MEREZHKO, Mikhail (Institute of Nuclear Physics)

Presenter: BOBRUSSOVA, Yuliya (Institute of Nuclear Physics Kazakstan)

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