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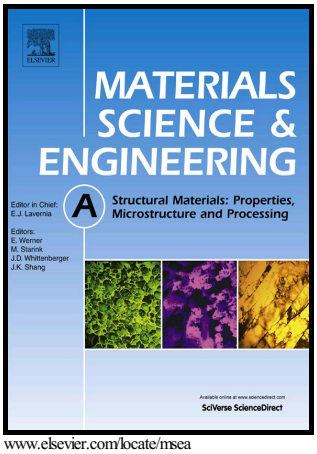

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The mutual effects of hydrogen and microstructure on hardness and impact energy of SMA welds in X65 steel

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Abstract

Micro-alloy steels are broadly used in gas and petroleum transportation industries. However, application of these steels in pipelines is challenged by hydrogen embrittlement due to presence of hydrogen sulfide in the medium. The present work deals with the interaction of hydrogen with plasticity of X65 steel. Two weld joints produced by common E7010-G and E7018 electrodes via shielded metal arc welding (SMAW) method were also investigated. It was revealed in microhardness test that direct charge of hydrogen to the surface did not lead to meaningful variations due to lamination as well as surface and sub-surface porosities. In fact, the effect of hydrogen on material plasticity was influenced by lamination and porosities. On the other hand, indirect charge on the tested surface led to increase in hardness by 12, 9 and 6 percent in base metal as well as in weld metals obtained from E7010-G and E7018 electrodes, respectively. Therefore, hydrogen atoms affected plasticity of X65 steel more harshly than that of weld metals; thus, the base metal is more sensitive to hydrogen embrittlement. Due to high strain rate, impact test does not provide sufficient time for hydrogen diffusion through notch during the test. No observation of any variations in impact energies of charged samples may hence be explained by uniform hydrogen concentration throughout the samples. The base steel was seen to be much more sensitive to hydrogen defects rather than weld metals of both electrodes due to possessing pearlite/ferrite interfaces. According to hydrogen concentration studies, E710-G weld metal had more hydrogen diffusivity than X65 steel and E7018 weld metal by four time and 25%, respectively. This was due to acicular ferritic microstructure of E710-G weld metal and its dislocation tangles that provided many reversible traps for hydrogen.