Hydrogen Embrittlement

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Hydrogen reduces the load-bearing ability and/or the mechanical energy absorption ability of many metallic alloys, ferrous and non-ferrous. The basic mechanism of this embrittling action is the decrease of the attractive interaction between metal atoms produced by the electronic disturbance due to adjoining hydrogen atoms at interstitial sites at interphase boundaries or in bulk lattice. This reduction can have two effects: a decrease in the stress necessary to separate the metal atoms colinearly leading to direct cleavage, and a decrease in the stress needed for shear separation of the metal atoms leading to enhanced dislocation generation and mobility and to localized plasticity.The latter effect decreases the energy required to propagate a crack. Which effect predominates in any one instance depends on many factors needing further understanding, such as the stresses at interfaces due to plastic incompatibility, stress gradients about a crack, dynamics and configuration of dislocations near a crack as affected by hydrogen, and interfacial cohesion as modified by impurities and by hydrogen.The kinetics of cracking has been advanced by consideration of the competition between hydrostatic stress and plastic strain in attracting hydrogen. Further understanding and the development of predictive models depends on better data and understanding of trap-affected hydrogen transport and of the absorption of hydrogen across impurity-loaded interfaces, and of the synergistic interaction of simultaneous hydrogen-aided cleavage and plastic tearing.