

**ABSTRACT:**

The possibilities of effective solutions of relevant technological problems are considered based on the analysis of fundamental physical aspects, elucidation of the nano-structural mechanisms and interrelations of aging and hydrogen embrittlement of materials (steels) in the hydrogen industry and gas-main industries. The adverse effects which these mechanisms and processes have on the service properties and technological lifetime of materials are analyzed. The concomitant fundamental process of formation of carbonyl-like and other segregation nanostructures at dislocations (with the segregation capacity 1 to 1.5 orders of magnitude greater than in the widely used Cottrell 'atmosphere' model) and grain boundaries is discussed in the context of how these nanostructures affect technological processes (aging, hydrogen embrittlement, stress corrosion damage, and failure) and the physicochemical properties of the metallic materials (including the technological lifetimes of pipeline steels).