

Thus, the use of electrodynamic screw devices is a promising direction in the development of plant raw material extraction technologies, which combines process intensification, increased product yield and reduced energy costs.

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SOLID MATERIALS FOR HYDROGEN STORAGE USING Ti

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The transition to environmentally friendly hydrogen energy is one of the main tasks of modern science and industry. However, the widespread introduction of hydrogen as the main energy carrier remains lacking in safe, compact and cost-effective methods of its storage. Traditional methods, such as gas compression under high pressure or liquefaction, have low efficiency and high risks when used. The best alternative is solid-phase storage of hydrogen in a bound medium in metal matrices. The effectiveness of such systems directly depends on the development of new materials with high sorption capacity and optimal operating temperature conditions. This study focuses on the modification of titanium alloys, as well as on the development of innovative high-entropy alloys (HEA) with improved thermodynamic and kinetic characteristics.

An important direction is the improvement of systems based on magnesium (Mg) and titanium (Ti). Magnesium and titanium alloys have a high theoretical capacity, but require overcoming significant thermodynamic barriers. It has been proven that the use of severe plastic deformation (SPD) methods, in particular equal-channel angular pressing (ECAP) and high-pressure torsion (HPT), allows creating a high density of lattice defects. These defects become paths for accelerated diffusion, which significantly reduces the hydrogen desorption temperature. Additional doping with rare earth elements (Y, Sm) and the introduction of catalytic additives (Ni, carbon nanotubes, graphene) significantly intensifies hydrogenation reactions. For example, in Mg-Ni-Y systems, the YH_3 phase plays the role of a catalyst for other hydrides, and nanostructuring by mechanical doping provides a significant improvement in kinetics. In addition, a promising and environmentally sustainable approach is the use of magnesium alloy waste as a secondary raw material for the production of hydrogen batteries [1].

In parallel, studies of solid solutions based on the V-Ti system are ongoing. It has been established that vanadium contributes to the stabilization of the BCC phase, which has a higher sorption capacity compared to Laves phases. Optimization of the V-Ti-Cr-Fe compositions by heat treatment (in particular at 1673 K) allows leveling the pressure plateau and increasing the reverse capacity. The use of lanthanum (La) and cerium (Ce) in these systems improves the activation properties and resistance of the material to poisoning by gas impurities [2].

The most progressive class of materials is high-entropy alloys (HEAs). Their uniqueness is due to four “main effects”: high configurationally entropy, slow diffusion, significant distortion of the crystal lattice and the “cocktail effect”. The design of such alloys is based on calculations of the parameters of the atomic radius δ , the mixing enthalpy ΔH_{mix} and the valence electron concentration (VEC). The dominant for hydrogen HEAs is the BCC structure, which, due to the large number of interstitials, ensures rapid hydrogen diffusion. Some systems, such as Ti-V-Zr-Nb-Hf, demonstrate record-breaking capacity performance with hydrogen-to-metal ratios H/M up to 2.5, making them a versatile platform for next-generation energy-saving systems [3].

Thus, the creation of effective solid-state hydrogen storage systems is based on a complex combination of nanostructuring, alloying and development of fundamentally

new metal matrices. Modification of alloys using intensive plastic deformation, catalytic additives and optimization of solid solutions opens up ways to improve the reversible capacity and resistance of materials to impurity poisoning. High-entropy alloys (HEAs), which, due to the unique effects of crystal lattice distortion, demonstrate high hydrogen capacity. Further development of these technologies and optimization of alloy compositions will allow the creation of highly efficient and cost-effective solid-state hydrogen storage devices.

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**HIGH-ENTROPIC ALLOYS AS A NOVEL MATERIAL FOR SOLID-STATE
HYDROGEN STORAGE**

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The global energy transition requires the development of safe and highly efficient hydrogen storage technologies. Traditional metal hydrides are being replaced by innovative multi-component metal systems. The current paradigm for the development of materials for solid-state hydrogen storage is shifting towards high-entropy alloys (HEA),