PLASMA PHASE TRANSITION IN HYDROGEN AT HIGH PRESSURES.

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The assumption of the existence of metallic hydrogen was suggested by Wigner and Huntington in 1935. An estimate of the metallization pressure at zero temperature at 25 GPa was obtained. However, a sharp increase in the reflection coefficient of hydrogen was observed at a pressure of 495 GPa and a temperature of 5.5 K, which was interpreted as the transition of solid hydrogen to the conducting phase. The work reviews theoretical and experimental works, as well as proposals on practical applications of metallic hydrogen. The emphasis is on the latest theoretical and experimental research and the original results of the authors of the report. Within the framework of the density functional theory and quantum molecular dynamics, the dependences of pressure, electrical conductivity, and proton-proton pair correlation functions (PCF) on the density in the range 1.14-2.0 g/cm^3 at temperatures 50 and 100 K were calculated. The pressure range is 300-1200 GPa, i.e. solid phase is considered. The calculations are carried out using the VASP package. The monoclinic lattice of the C2/c group is used as the initial configuration, since this structure is the most stable in the pressure region above 260 GPa. A structural transition was observed at a pressure of 607 GPa, characterized by a marked jump in the electrical conductivity and a sharp decrease in the number of H_2 molecules. At a density of 1.563 g/cm^3 and a pressure of 607 GPa, the PCF peak disappears at a distance of 0.74 Å corresponding to the interatomic distance in the H_2 molecule, which is an indication of the decay of the H_2 molecules. At the same time, the electrical conductivity value sharply increases to 85300 (Ohm·cm)$^{-1}$ and the PCF peak appears at a distance of 0.92 Å. This distance is equal to the interproton distance in the molecular ion H_3^+. This position of the first maximum remains unchanged in the pressure range of 607-832 GPa. This indicates the implicit appearance of H_3^+ ions in the structure of solid hydrogen upon its transition to a conducting state. Thus, the nature of the transition combines ionization with structural changes. With further compression, the first maximum of the PCF begins to correspond to the average distance between protons at a given density, which indicates the complete dissociation of hydrogen ions. Strong ionization during the phase transition in dense solid hydrogen/deuterium brings this transition closer to the plasma phase transition in the fluid hydrogen.