EFFECT OF NANOSTRUCTURED ALUMINUM SURFACE ON N-HEXANE RADIOLYSIS PROCESSES

This paper presents the results of studies of the process of radiation-chemical decomposition (radiolysis) of n-hexane on the surface of pre-radiation-oxidized aluminum plates containing thin oxide films of different thicknesses to identify the role of the nanostructured Al surface in the dynamics of the decomposition process and its effect on the rate of formation and the yield of the final radiolysis products. At the same time, the kinetics of molecular hydrogen accumulation during n-hexane decomposition on the Al surface in its relationship with the growth of oxide films was studied.

In the work, metal plates of aluminum Al-00 were used. Nano structuring of the Al surface was created by preliminary oxidation of aluminum plates in contact with water under the action of γ-radiation at room temperature. The absorbed dose varied within the range of $\Phi\boxtimes$=0.5-150 kGy. In this case, the metal surface was modified and a nanostructured oxide coating was formed, which has an unusual property. Radiation-oxidized Al plates contained oxide films on the surface with a thickness of 8 to 600 nm. The surface of the original and radiation-oxidized Al plates was studied using an atomic force microscope.

The influence of nanostructured Al surface on the course of radiation-chemical decomposition of n-hexane is considered. Based on the kinetics of H_2 accumulation, the rates of formation $W(H_2)$ and radiation-chemical yield $G_{total}(H_2)$ of molecular hydrogen are determined. It is revealed that a decrease in the thickness of oxide films by ~ 2 orders of magnitude leads to an increase in the rate of hydrogen formation by ~ 7 times (from 1.1 to 7.6×10^{15} g-1 s-1), while the yield of H_2 increases from 4.3 to 8.2 molecules / 100 eV). The obtained results are explained by the difference in the degree of defectiveness of the surfaces of radiation-oxidized aluminum plates and an increase in the density of radiation-generated centers. An abrupt increase in the rate of H_2 formation is observed in the region of small thicknesses (d=8-80 nm).

Further increase in the thickness of oxide films from 80 to 600 nm leads to a monotonic decrease in the value of the rate of formation of molecular hydrogen. At the same time, the density of surface defect states and radiation-generated hole centers increases, which leads to an increase in the probability of n-hexane decomposition at these centers. These processes are most effective if the thickness of the oxide films is commensurate with the values of the mean free path of charge carriers (electrons and holes) in the metal and oxide and is d~λ = 5-60 nm. When this condition is met, the energy absorbed by the adsorbent (AI-AI2O3) is completely transferred to the surface adsorbed molecules of n-hexane, which causes its decomposition by the recombination mechanism. Further increase in the thickness of oxide films from 80 to 600 nm leads to a monotonic decrease in the value of the rate of formation of molecular hydrogen. At the same time, the density of surface defect states and radiation-generated hole centers increases, which leads to an increase in the probability of n-hexane decomposition at these centers. These processes are most effective if the thickness of the oxide films is commensurate with the values of the mean free path of charge carriers (electrons and holes) in the metal and oxide and is d~λ = 5-60 nm. When this condition is met, the energy absorbed by the adsorbent (AI-AI2O3) is completely transferred to the surface adsorbed molecules of n-hexane, which causes its decomposition by the recombination mechanism.

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