New Discovery of Conditions for Hydrogen Explosive Combustion in Platinum Foil

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When hydrogen is sprayed onto a platinum foil (0.1μm thick), explosive combustion occurs without the use of fire. The reaction principle is postulated to be a surface reaction between hydrogen and oxygen atoms dissociatively adsorbed on the platinum surface by catalytic action. However, no explosion occurred when the entire back side of the surface undergoing hydrogen spraying was covered with cellophane tape. Therefore, we hypothesized that oxygen is necessary on the backside of the platinum foil for hydrogen spraying to cause an explosion. To investigate this, a beaker filled with nitrogen, carbon dioxide, air, and oxygen was covered with a film embedded in a platinum foil (1×1 cm^2), and hydrogen was sprayed from the top. Explosions occur only under oxygen and air conditions. The platinum surface was observed via field-emission scanning electron microscopy, revealing eight holes of 1μm diameter per $6×10^3 μm^2$ area. These two facts prove that the hypothesis is correct. The surface of the platinum foil had a smooth structure, whereas that of the holes had an uneven structure. Convex and concave structures can accommodate the molecular orientation of oxygen and promote adsorption and dissociation, whereas smooth structures hinder the absorption of oxygen. Therefore, the explosion did not occur on the platinum surface but required the presence of a hole and oxygen on the back surface. This study overturned the reasoning that had previously been considered common knowledge. Furthermore, the importance of the surface structure and molecular orientation of oxygen in the surface reactions was demonstrated.

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