290j Hydrogen Permeation Behavior of Thin Pd Film on Alpha Alumina Hollow Fiber Based on a Novel Catalyzing Process

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The effective and economical method for preparing thin Pd-based composite film is the electroless plating technique. The vital prerequisite of defect-free thin Pd film using this technique is to obtain a homogeneously catalyzed substrate surface. A novel process based on the catalyzing the substrates using a polymer solution containing Pd metal ions was developed by us, and the thin defect-free Pd film was deposited on the commercially available alpha alumina hollow fiber (AHF). In this presentation, the hydrogen permeation behavior of the Pd/AHF composite film was studied in detail. The hydrogen permeation flux versus the hydrogen pressure difference were measured in a wide temperature range (623-873 K) by single gas method, showing a hydrogen flux as high as 0.82 mol/(m^2 s) at 873 K with a hydrogen pressure difference of 200 kPa. Under the same condition, the helium leakage is negligibly small, appearing the complete hydrogen selectivity. The hydrogen partial pressure exponents (n values) in hydrogen permeation equation, $J=Q/l\ (PH^n-PL^n)$, are different (0.65-0.85) at different operating temperatures (623-873 K). This shows that the hydrogen permeation process is controlled by both bulk diffusion and surface reaction, and the surface reaction plays an increasing role with the decreasing temperature. At the same time, the hydrogen permeation activation energy was calculated at high temperature zone (823-873 K) and low temperature zone (623-673 K) respectively, the values of 14.8 kJ/mol and 28.5 kJ/mol were obtained. This indicates that the hydrogen permeation is mainly controlled by bulk diffusion at high temperature zone, and by surface reaction at low temperature zone. The membrane stability was checked by gas changing cycles between hydrogen and helium, showing steady hydrogen permeation flux and complete hydrogen selectivity during 40 gas changing cycles. Moreover, after operating as long as 160 h, the hydrogen permeation flux still keeps original value of 0.33 mol/(m^2 s) at 773 K with a hydrogen pressure difference of 100 kPa, and the hydrogen selectivity versus helium under the pressure difference of 200 kPa is still infinite.