Hydrogen Isotope Effects of Ti, Zr, U Metals

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Titanium, zirconium and uranium are important hydrogen-storage materials which are widely used in tritium technology because of their excellent characteristics. So their reaction characteristics and parameters are concerned for the fuel cycle of fusion reaction. In the present work, the deuterium and tritium absorption and desorption behavior by titanium, zirconium and uranium on isotope effects of thermodynamics and kinetics are investigated.

The *p-c*-T curves of deuterium and tritium absorption by titanium and zirconium were measured using method of step equilibrium. The *p-c*-T curves have the same trend, there are one plateau at temperature below 300℃ and two plateau at temperature above 300℃ for titanium but one plateau at temperature below 525℃ and two plateau at temperature above 525℃ for zirconium. The thermodynamic parameters on different phases were determined according to the Van't Hoff equation and there are obvious thermodynamic isotope effects. The lagging effect was not observed in reversible process of hydrogen absorption and desorption by titanium on our experimental condition but it's existent for zirconium.

The pressure changes during the absorption of deuterium and tritium by titanium, zirconium and uranium were investigated at different temperature range by using the method of reaction rate analysis and then the rate constants are calculated. The results show that the rate constants increase with raising temperature for titanium but decrease with raising temperature for zirconium and uranium. The activation energy value of absorbing deuterium and tritium obtained by this analysis are (110.2±3.0)kJ.mol^{-1},(155.7±3.2) kJ.mol^{-1} respectively for titanium and （-25.9±0.7）kJ.mol^{-1}, （-16.8±0.8）kJ.mol^{-1} for zirconium and （-42.8±0.3）kJ.mol^{-1}, （-43.2±1.2）kJ.mol^{-1} for uranium. So there are remarkable kinetic isotope effects for titanium, zirconium and unremarkable kinetic isotope effects for uranium.

The pressure changes during the desorption of deuteride and tritide were investigated for titanium, zirconium and uranium. The activation energy of desorption are (42.3±1.9)kJ.mol^{-1}, (62.1±1.6)kJ.mol^{-1} respectively for titanium and （40.1±0.8）kJ.mol^{-1}, （57.7±1.6）kJ.mol^{-1} for zirconium and (26.3±0.4)kJ.mol^{-1}, (27.7±0.6)kJ.mol^{-1} for uranium. there are remarkable isotope effects for titanium, zirconium and unremarkable isotope effects for uranium.

In addition, the characteristic of H_2-D_2 mixture absorption by titanium were researched and the separation factors(α) of hydrogen isotopes were measured. It was found that there is a linear relation as $\ln\alpha = -0.13 + 107/T$.

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