New insights into pathways and kinetic of magnesiothermic reduction of titanium tetrachloride in titanium metallurgy

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Abstract

There is still no consensus on the reaction pathways and kinetic modeling of magnesiothermic reduction of titanium tetrachloride, and the theoretical innovations are required for further research of titanium metallurgy. We determined efficient reaction pathways via chemical reaction stoichiometry methodology, and proposed an innovative kinetic modeling approach of magnesiothermic reduction of titanium tetrachloride. We explained the reaction pathways by the steps of the phase change near the gas-liquid interfaces, the homogeneous reaction in the gas phase, the heterogeneous reduction near the gas-liquid interfaces, and the like dissolves like in the liquid phase. Net chemical reaction rate of titanium sponge decreased with decreasing of titanium tetrachloride feeding rata and with increasing of gauge pressure. The excellent fitness of the reaction rate constants, f(Δp) and k(Tin), show that the proposed kinetic equation accuately describes the reaction mechanism, and is reasonable and acceptable for magnesiothermic reduction of titanium tetrachloride in titanium metallurgy.

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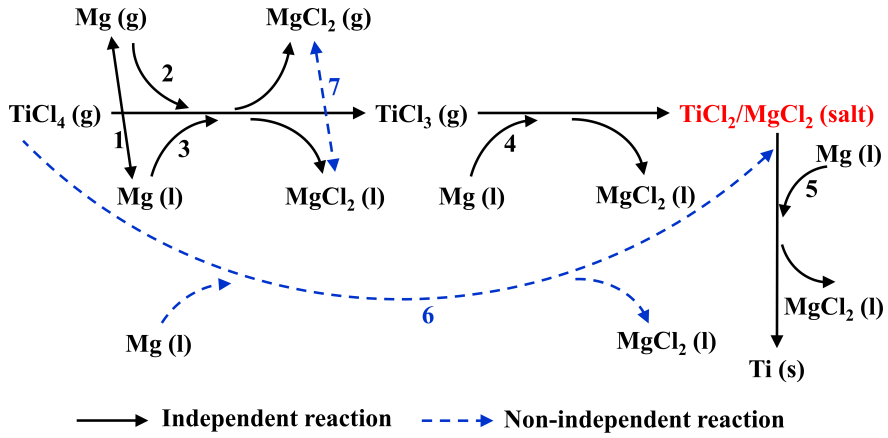
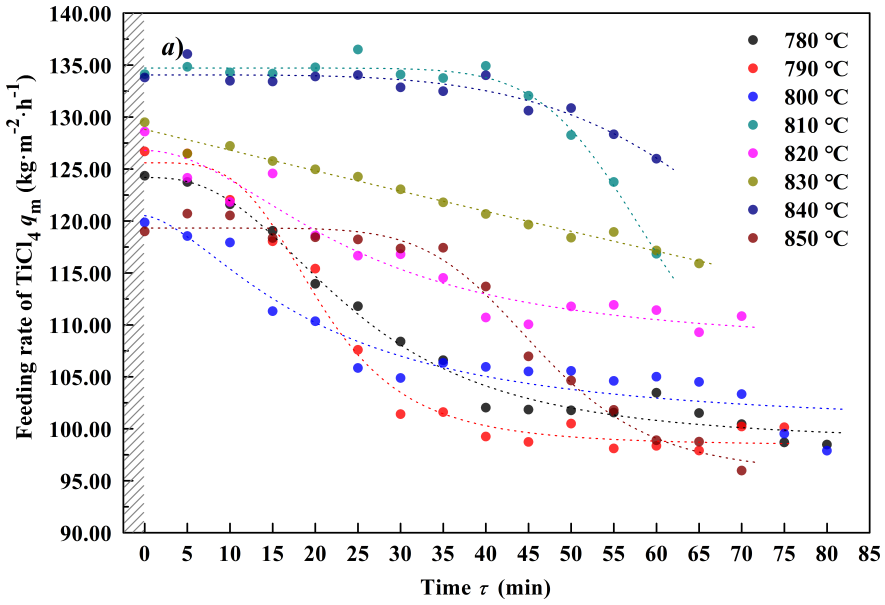
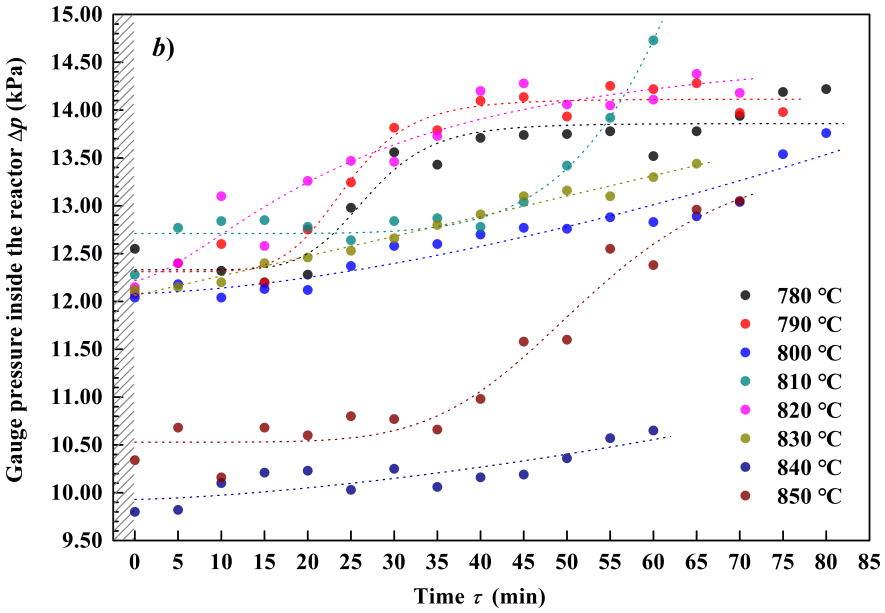
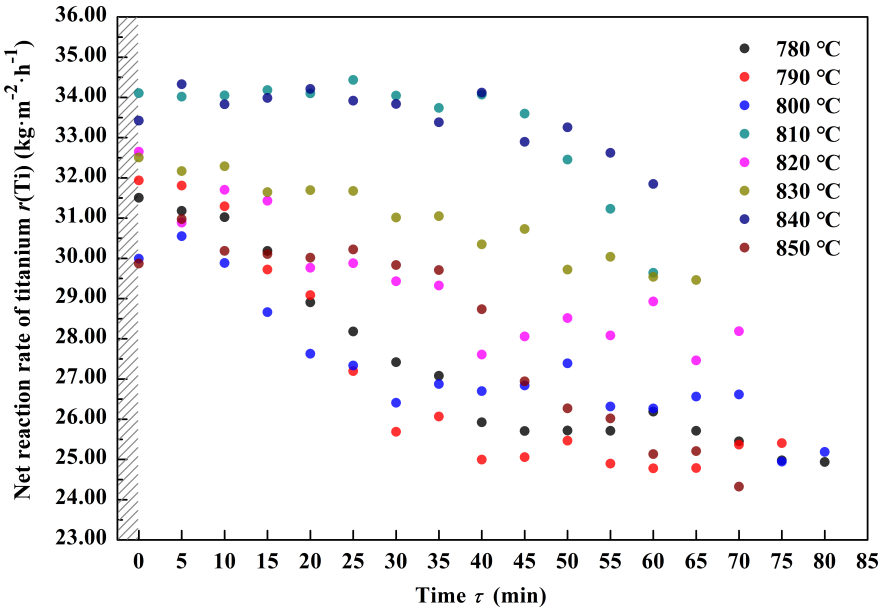
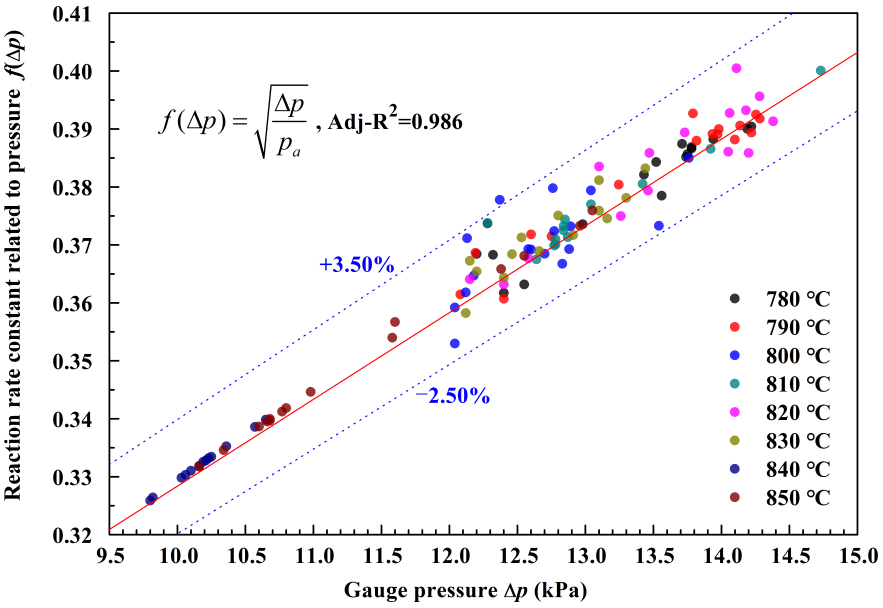


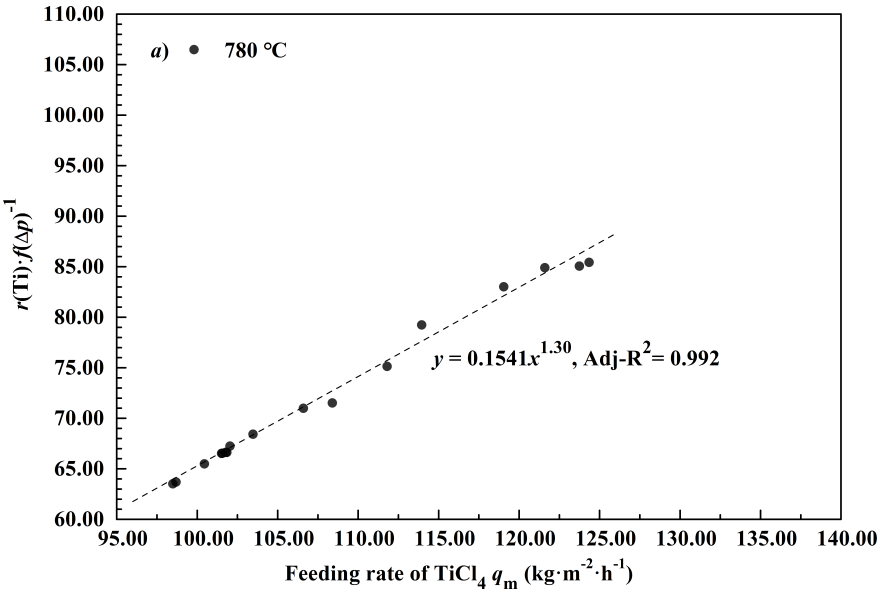
Overall chemical reaction: $TiCl_4$ (g)+2Mg (g, l)=Ti (s)+2$MgCl_2$ (g, l)

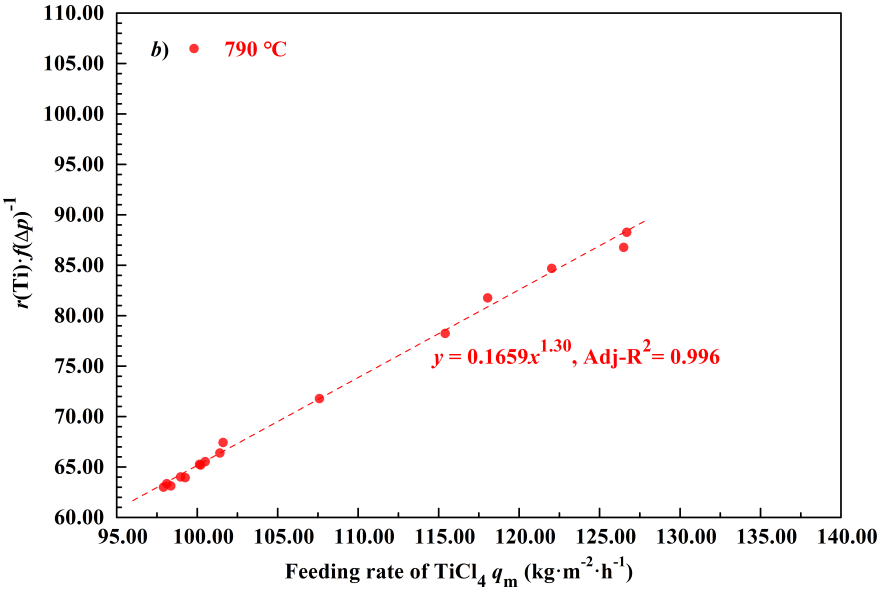


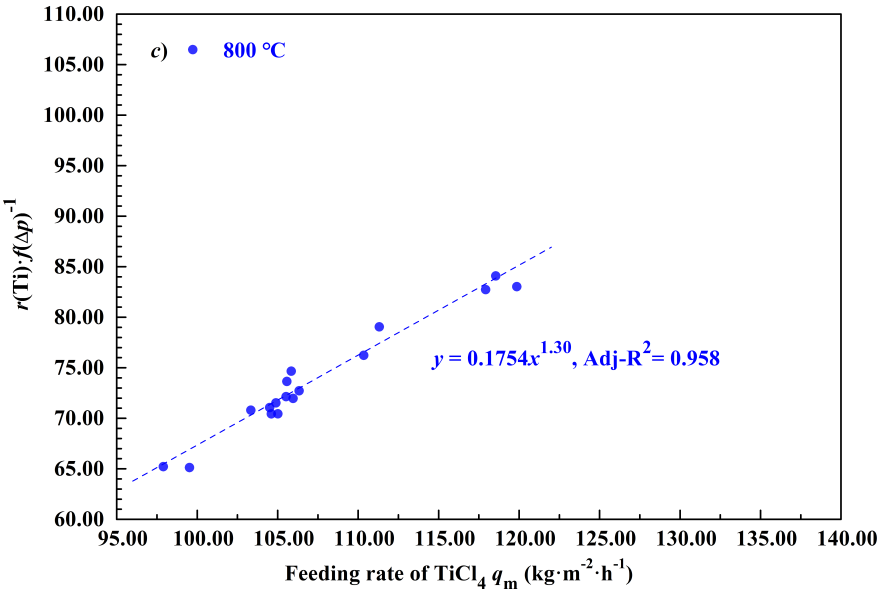


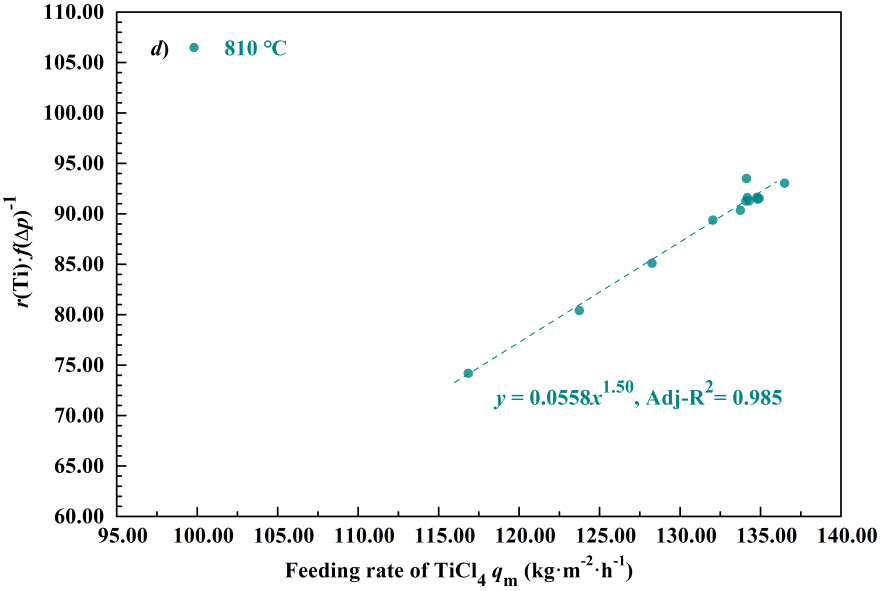


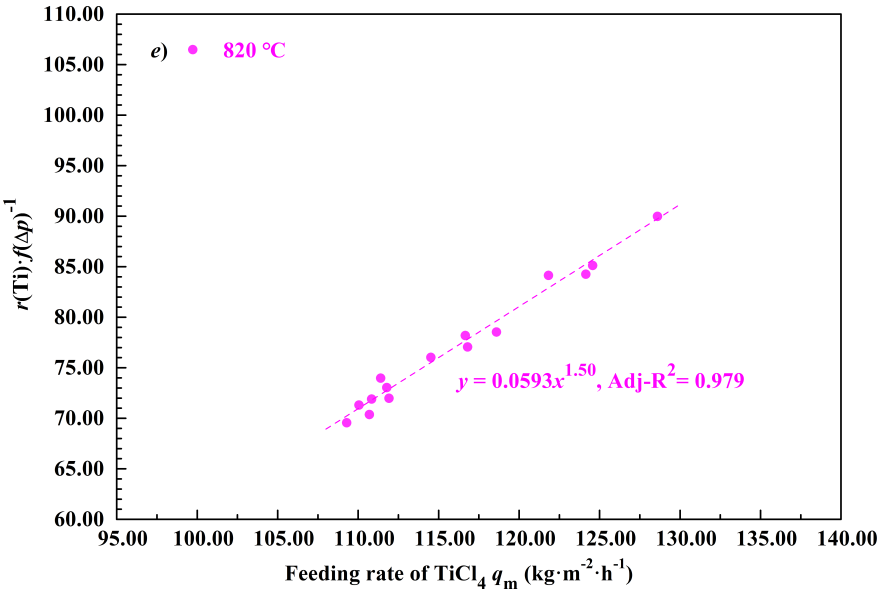


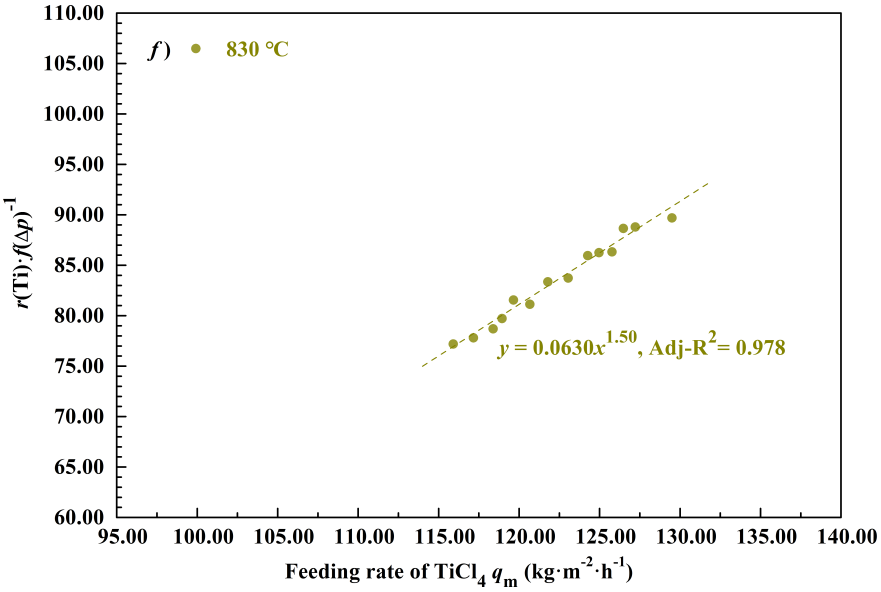


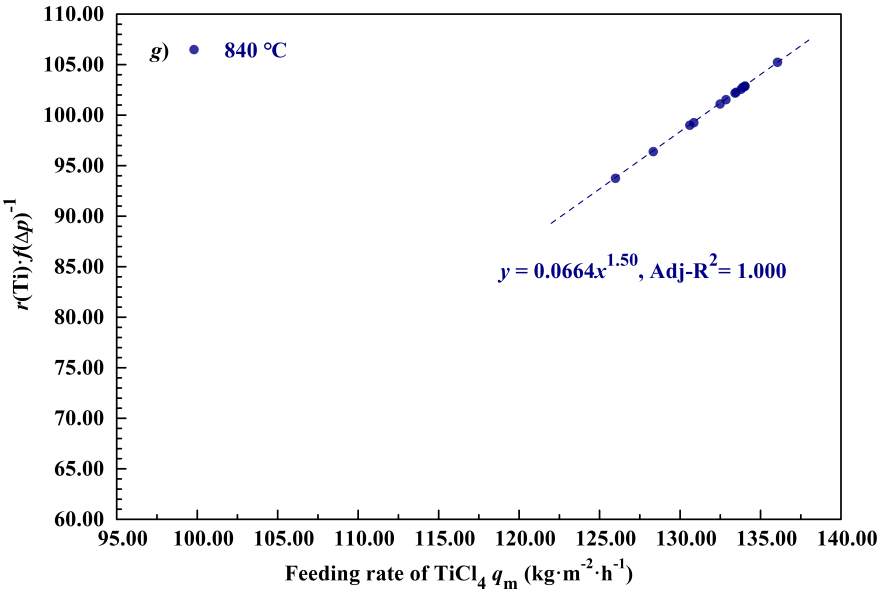


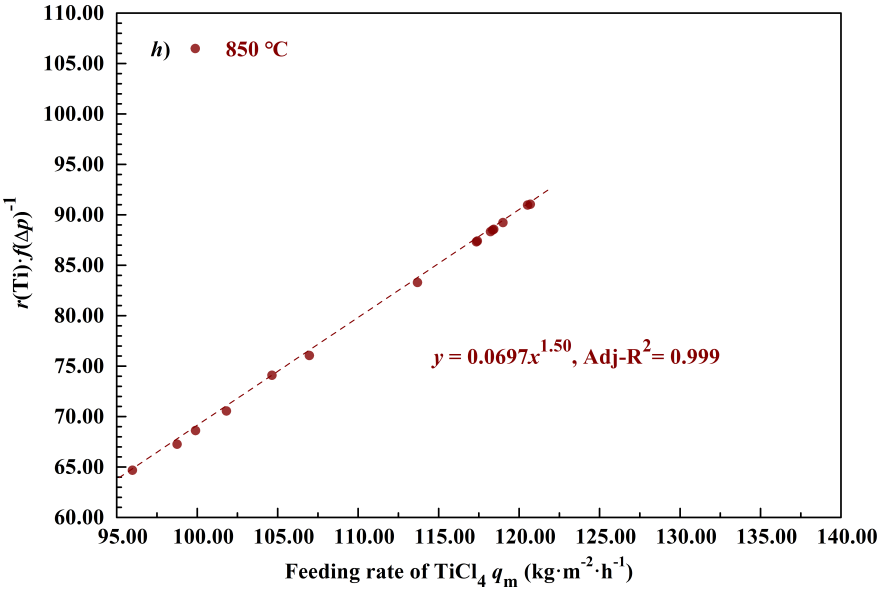


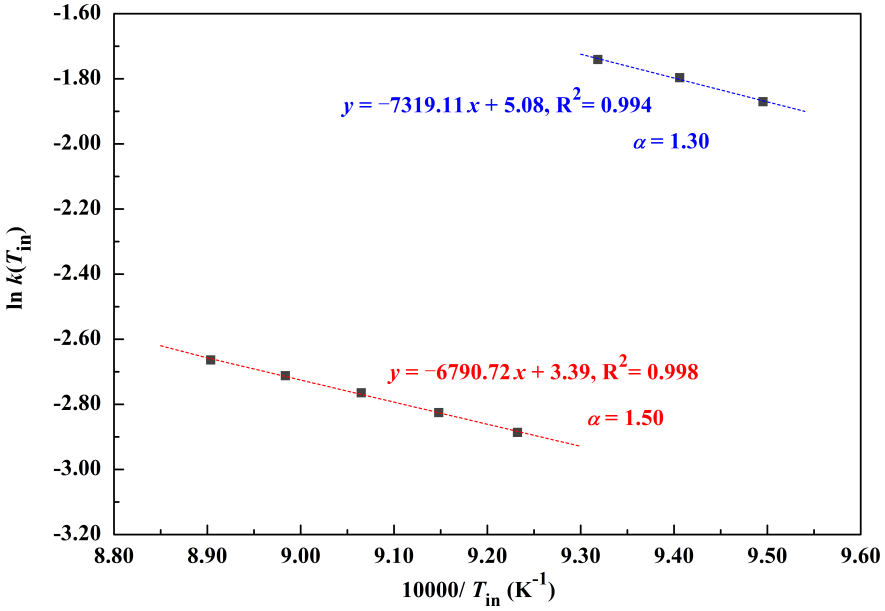


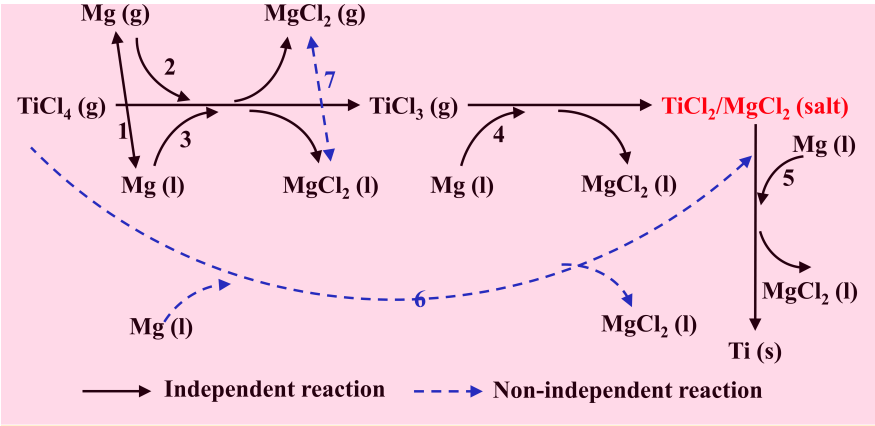












Overall chemical reaction: $TiCl_4\,(g)+2Mg\,(g, l)=Ti\,(s)+2MgCl_2\,(g, l)$

$$r(\mathrm{Ti})=\frac{dm(\mathrm{Ti})}{d\tau}=k(T_{\mathrm{in}})\,f(\Delta p)\,q_{\mathrm{m}}^{\alpha}$$