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A Macrokinetic Study of the High-Temperature Solid-Phase Titanium-Carbon Reaction

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An experimental method, electro thermal explosion (ETE), is used to measure the macro kinetic parameters of the high-temperature titanium/carbon reaction. Different stages of the reaction have been identified, but the focus of this study is on the reaction between solid titanium and solid carbon, i.e., prior to the melting of titanium. The reaction has high activation energy, and an electric current is used to heat the cylindrically shaped sample to a specified temperature. The current is shut off at a temperature below the melting point of titanium; any further temperature rise is only due to reaction. The output of the ETE equipment is temperature time data that can be processed to recover the kinetic parameters. The activation energy and preexponential factor of the reaction rate constant are calculated and comprise 214 kJ mol-1 and (6.2 (1.5) _ 107 s-1, respectively. An important aspect of solid-phase reactions is the contact area between reactants. The contact area between titanium and carbon particles is calculated, and the reaction constant is corrected for this effect.

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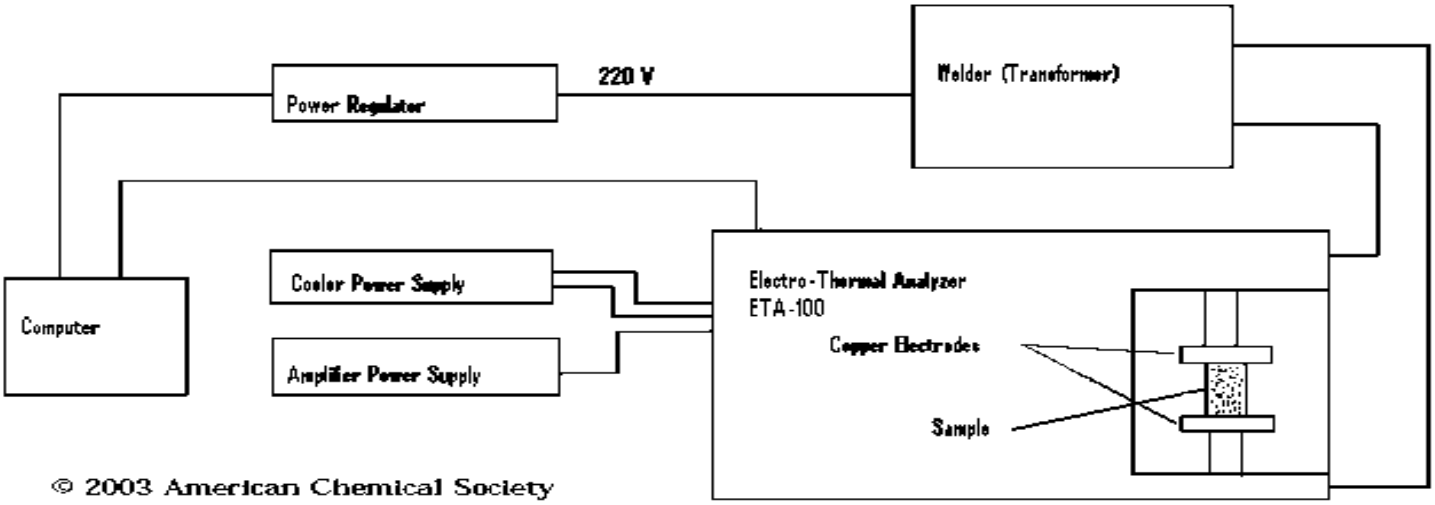
Figure 1. Schematic of ETE equipment.



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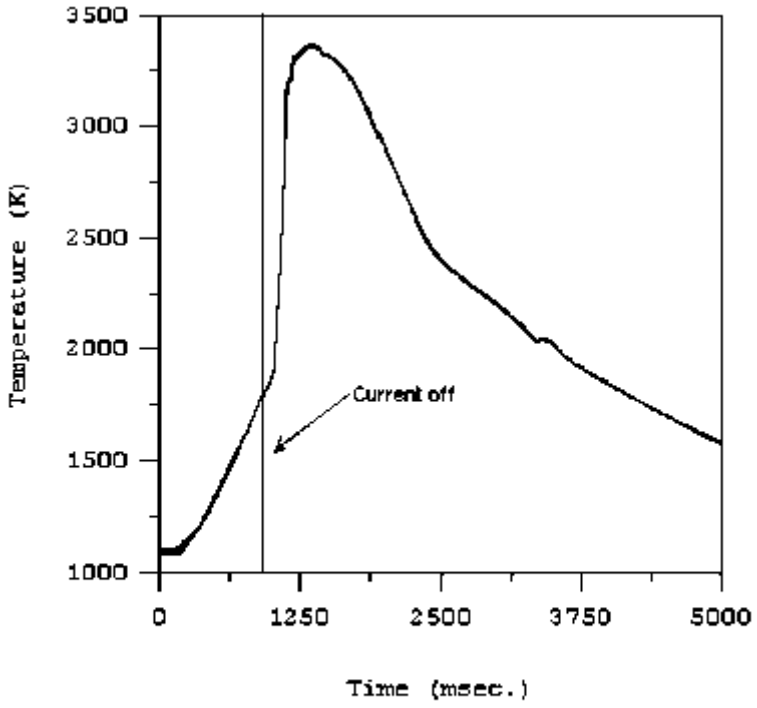

Figure 2. Experimental data of temperature (averaged over channels 9 and 10) vs time.

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Figure 3. Conversion vs time.

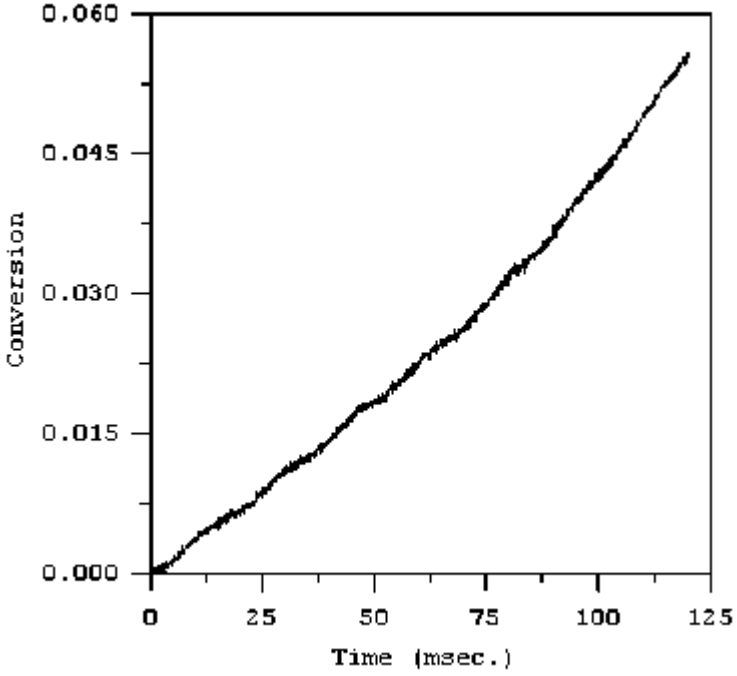

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Figure 4. Arrhenius dependence.

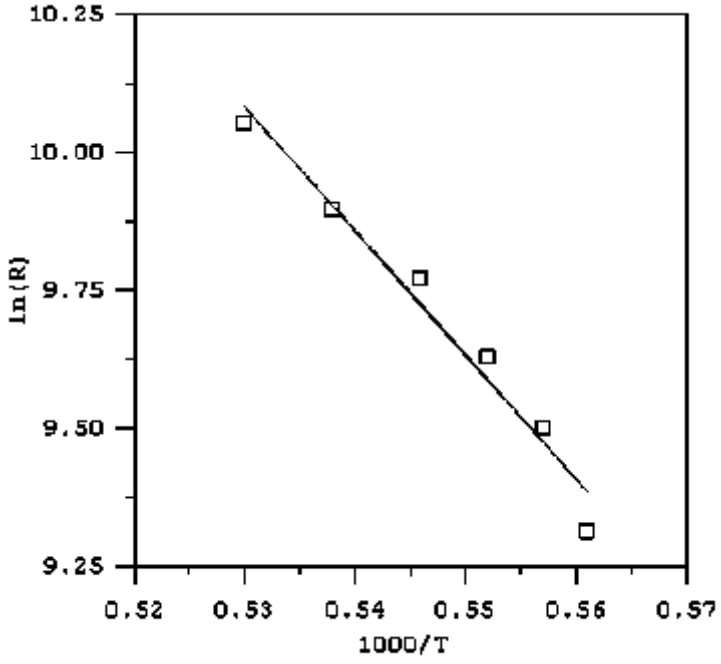

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Figure 5. Adsorption isotherm for titanium powder, 44 μm.

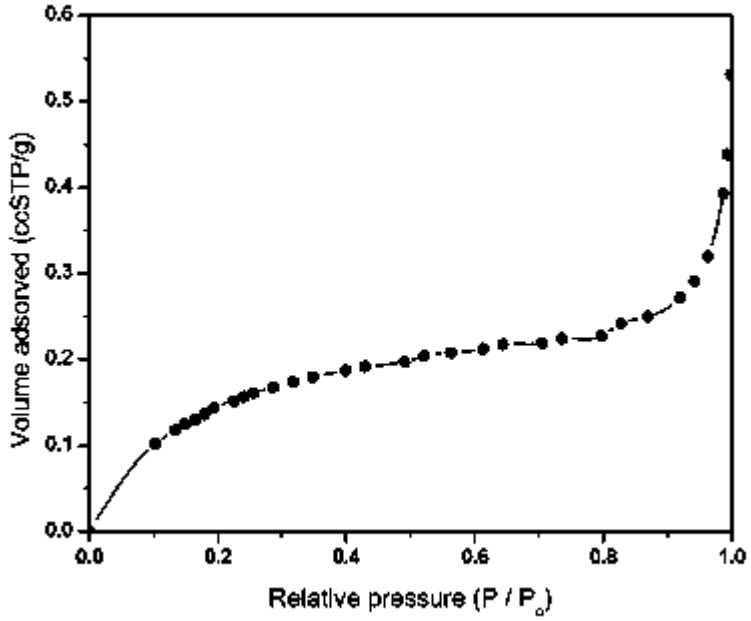

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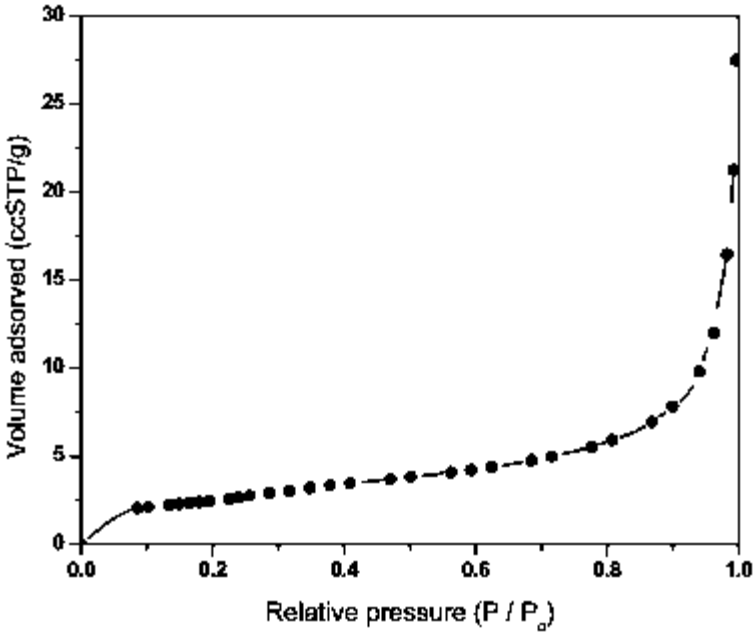
Figure 6. Adsorption isotherm for carbon powder, 44 μm.



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