INFLUENCE OF RUTHENIUM DISPERSITY ON ITS ADSORPTION AND CATALYTIC PROPERTIES

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Hydrogen adsorption and the activity of Ru black of various dispersity in hydrogenation reactions have been investigated using a variety of methods. Decreasing dispersity decreases the heat of hydrogen adsorption, the activity and selectivity of the catalyst in the hydrogenation of various organic compounds.

The existence of a correlation between catalyst dispersity and activity is still open to debate. Boudart and Bond /1, 2/ divide reactions into structure-sensitive and structure-insensitive ones. In contrast to platinum, few studies are available on the dependence of the catalytic activity of ruthenium on its dispersity /3, 4/.

We now report results on the influence of the dispersity of Ru black on hydrogen adsorption and the activity in hydrogenation. Ru black was prepared by Zelinskii’s method /5/ from Ru(OH)Cl$_3$ and then thermally treated at 100, 200 and 300 °C in a hydrogen flow for 3 hrs. To study hydrogen adsorption, potentiometric curves in 1 N H$_2$SO$_4$ were recorded on a P-5848 potentiostat. The speed of potential sweep varied from 0.05 to 1 mV/sec. At 0.1 mV/sec, hydrogen adsorption on all catalysts is irreversible and the curves are reproducible. Hydrogenation was carried out in a catalytic vessel /6/. The composition of the products and the purity of the
reactants were analyzed on Tsvet-100 and Chrom-4 chromatographs, the latter having a flame ionization detector.

The Ru surfaces determined by the BET and electrochemical methods from krypton and hydrogen adsorption, respectively, correlate well (Table 1). Electron microscopic studies were performed on an EVM-100L instrument with a resolution of 2–3 Å.

If Ru black is reduced at 100 °C, the I vs. \( \phi \) curve shows a current maximum at 100 mV (Fig. 1). The hydrogen region ends at 200 mV, followed by double layer recharge and surface oxidation. Upon increasing the temperature from 20 to 60 °C, hydrogen adsorption first increases, then starts to fall. The I vs. \( \phi \) curve of Ru black reduced at 200 °C shows the displacement of the current maximum.