ON THE STRUCTURE AND ACTIVITY OF A Pt/C CATALYST SUBJECTED TO REPEATED DEACTIVATION AND REGENERATION CYCLES


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Electron microscopic studies reveal that repeated air/hydrogen regeneration cycles cause irreversible structural changes of a Pt/C catalyst involving sintering and migration of the platinum over the support. This is reflected by a serious decrease of the catalytic activity. With hydrogen treatment only, these effects are less significant.

INTRODUCTION

Zelinskii’s platinum on activated charcoal support (containing 15–20 % metal) /1/ has long been used as an excellent metal catalyst of various hydrocarbon transformations /2/, both in the presence and absence of hydrogen /3/. Nevertheless, no
studies of its morphology have been reported so far. The only electron microscopic study of Pt/C sintering found in the literature refers to a catalyst with 0.12–9.33 metal content /4/.

The present paper reports an electron microscopic study of the structural changes of Pt/C caused by its various deactivation – regeneration (D–R) treatments.

EXPERIMENTAL

The activity of the catalyst was checked in a pulse-microanalytical system /5/, using either helium or hydrogen as the carrier gas. Electron micrographs were taken with a Zeiss-EM transmission instrument.

RESULTS

Catalyst activity

Two different runs have been carried out; in one run, pulses of 3-methylpentane and methylcyclopentane, respectively, were introduced at 300°C, followed periodically by a one hour hydrogen flow at 330°C. With Pt-black, hydrogen treatment without air proved to be rather ineffective in restoring the catalytic activity /5, 6/. Therefore, a second run involving regeneration after hydrocarbon pulses with air and subsequent hydrogen treatment was carried out at 360°C, in order to obtain more marked effects (Table 1).

Electron microscopy

The only type of platinum visible on an untreated Pt/C sample is a finely dispersed "trimming" on the edges of carbon particles (Fig. 1a). After Run I, this seems to have suffered serious sintering (Fig. 1b). In addition, over graphitic carbon particles, fine platinum aggregates about 300 Å in size can be observed (this cannot be seen in the micrographs). These must have been formed via an aggregation process described in Ref. /4/.