Radiation-Induced Catalytic Activity of Nickel Oxide

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The fact that the irradiation of nickel oxide with γ-rays results in changes in surface phenomena and in the reduction process by hydrogen has been suggested previously.[1] The present communication will present evidence that the induced catalytic activity with γ-irradiation leading to the decomposition of hydrogen peroxide solution is closely connected with the chemisorbed oxygen induced by radiation.

The pure nickel oxide sample was prepared in a manner identical with that described previously.[1] The samples were irradiated to total doses of $\sim 8\times10^8$ r. in air at room temperature, with Co-60 gamma-rays. The catalytic activity of the nickel oxide was then determined by using the decomposition of a 7.5% hydrogen peroxide solution as a model reaction, in which the rate of the reaction was followed by reading the volume of oxygen evolved per minute. A 0.2 g. catalyst sample was used for each run. The reaction temperature was 40°C. The chemisorbed oxygen was estimated by its ability to oxidize potassium iodide in a hydrochloric acid solution, in fact, the quantity of Ni^{3+} ions was determined. Therefore, the results are represented as excess oxygen, two Ni^{3+} ions corresponding to one O^{2-} ion.

The catalytic activity and chemisorbed oxygen due to γ-irradiation are presented as a function of the radiation dose in Fig. 1. Both values were found to increase with the radiation dose, being remarkable over a total dose of about

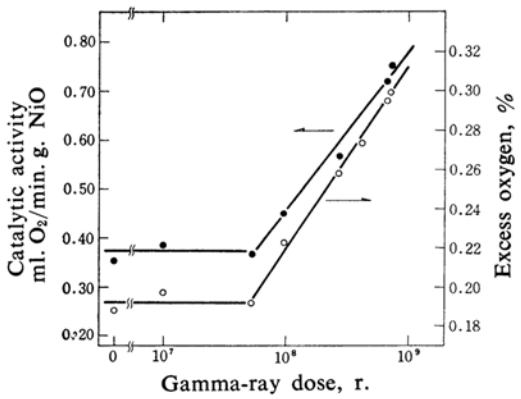

Fig. 1. Catalytic activity and excess oxygen as a function of γ-ray dose.

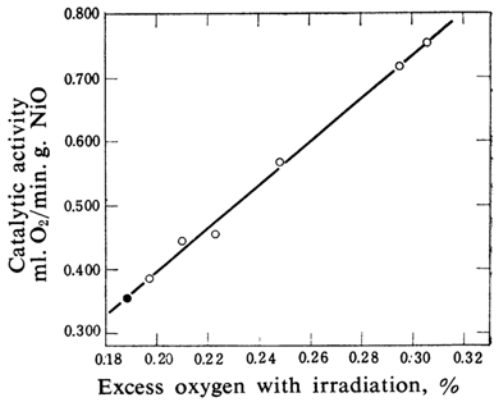

Fig. 2. Catalytic activity vs. excess oxygen with γ-irradiation.

1×10^8 and reaching a level over twice as great as not-irradiated nickel oxide. No differences in the B. E. T. surface area with the irradiation were observed. Figure 2 shows the induced catalytic activity as a function of the oxygen chemisorbed with irradiation; a linear relationship was obtained. Similar relations have been observed in the case of oxidized chromina-alumina catalysts.[2,3] From the present results, it can be concluded that the catalytic sites on nickel oxide are closely associated with the oxygen chemisorbed on the surface with γ-irradiation.

Although some investigators[4,5] have shown the radiation induced catalytic activity on nickel oxide to be concerned with the characterization of defects with radiation damage, the mechanism of its catalysis is still not clear.

We, however, would like to suggest that catalytic action takes place preferentially at the oxygen chemisorbed with irradiation. Further study is now in progress to reveal which state of adsorbed oxygen, O_2^-, O^- or O^{2-}, contributes to the catalysis.

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