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Author(s)	KOMURO, Isao; FUJITA, Yuzaburo; KWAN, Takao
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## Short Notes

### PHOTOSENSITIZED OXIDATION OF ISOPROPYLALCOHOL IN THE PRESENCE OF ZINC OXIDE

By Isao KOMURO, Yuzaburo FUJITA and Takao KWAN\*

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As reported previously<sup>1)</sup>, two of us (Y.F. and T.K.) found that photodesorption of oxygen takes place on reduced zinc oxide whereas it turns to irreversible sorption on oxidized sample. This opposite fashion of the photoresponse in the adsorption of oxygen stimulated us to investigate how these phenomena should be associated with the photosensitized oxidation reaction<sup>2)</sup> known to occur on zinc oxide. Experiments were made therefore along with this interest.

The oxidation of isopropylalcohol by oxygen in liquid phase was chosen for the purpose. Commercial zinc oxide powder (guaranteed reagent) supplied by *Kanto Kagaku Co.* was outgassed at 480°C for one hour in a vacuum. On cooling it was poured into isopropylalcohol. This zinc oxide sample is called here as reduced zinc oxide. On the other hand, the commercial zinc oxide was used without any special pretreatment. The sample is supposed to be in oxidized state since the d.c. electrical resistance measurement has shown that it possesses a resistance value as large as that of oxidized zinc oxide or is much larger than that of reduced zinc oxide.

A 50 ml dried isopropylalcohol containing 2 gram reduced or oxidized zinc oxide was put into a round Pyrex flask having three openings, two of which being for thermometer and mercury manometer respectively and the remaining being connected to reflux condenser and then to gas burette.

Oxygen was introduced from the gas burette into the flask immersed in 65°C thermostat. The oxidation reaction was allowed to proceed with stirring reactant phase operated by magnetic rod placed in the flask. The apparatus was isolated when working. The oxidation was followed by recording the decrease in the gas volume of the burette at a constant pressure. The partial pressure of oxygen inside the flask was estimated to be 440 mm Hg during the reaction.

\*) I. K.: Department of Chemistry, Hokkaido University.

Y. F. and T. K.: Research Institute for Catalysis, Hokkaido University.

1) Y. FUJITA and T. KWAN, *Bull. Chem. Soc. Japan* **31**, 380 (1958).

Y. FUJITA and T. KWAN, *this Journal* **7**, 25 (1959).

2) For example see M. C. MARKHAM and K. J. LAIDLER, *J. Phys. Chem.* **57**, 363 (1953).

Irradiation of light was made by Mazda Mercury Lamp SHL 100 UV without filter of any kind but through the window of the thermostat. The reaction product was pipetted and subjected to gas chromatographic and chemical analyses after the measurement of the oxidation rate. The temperature of the oxidation reaction was determined by the thermometer immersed directly in the liquid phase of the reacting system. Illumination caused the temperature of the system to rise less than 2°C.

It was confirmed that without illumination little consumption of oxygen occurs on reduced zinc oxide kept at 65°C. Illumination however brought forth distinct

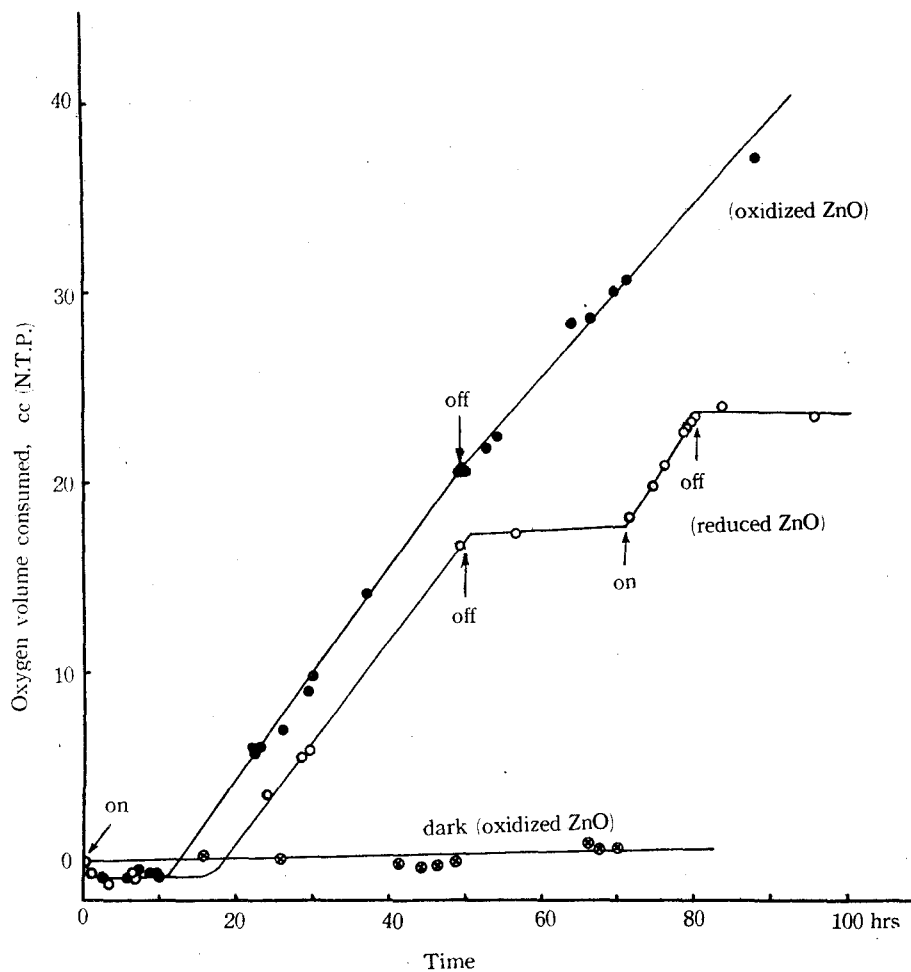


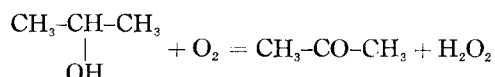
Fig. 1. Oxidation of isopropylalcohol by oxygen on zinc oxide with or without illumination.

$T$ : 65–67°C.  $P_{O_2}$ : 440 mm Hg.

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consumption of oxygen. On intercepting light, the consumption occurring steadily was found to cease apparently. Reillumination caused consumption of oxygen again to proceed, so that the photocatalytic oxidation of isopropylalcohol was almost reversible with respect to on or off of the light switch.

Now, in the case of oxidized zinc oxide, the photosensitized oxidation reaction took place quite similarly as the case on reduced zinc oxide while the reaction did not proceed without illumination beyond the period of 70 hours. However strikingly different behavior was that interception of light still permits the oxidation reaction to proceed with a speed almost equal to that of illumination. All the rate data for the oxidation of isopropylalcohol are shown in Fig. 1. Gas chromatographic and chemical analyses indicated that the product contains nothing other than acetone and hydrogen peroxide. The oxidation reaction may hence be expressed by



As shown previously,<sup>1)</sup> adsorbed oxygen due to illumination was unable to desorb on intercepting light whereas photodesorption was fairly reversible. If it is accepted that the photoresponse of this kind should hold even during the progress of the oxidation reaction of isopropylalcohol, the different photocatalytic behavior shown above respectively on reduced and oxidized zinc oxide is not unexpected. Because the catalyzing surface of reduced zinc oxide varies, when oxygen is present, depending on whether the light is switched on or off whereas the surface of oxidized zinc oxide, once experienced illumination, may maintain its state even during the light is intercepted.

On the other hand, almost identical photocatalytic activity shown by the two zinc oxide samples during the initial stage, including the induction period and later, is unexpected and rather embarrassing. Further work is in progress.

## ISOTOPIC SEPARATION FACTOR OF SLOW DISCHARGE MECHANISM OF HYDROGEN ELECTRODE REACTION. II

By Takuro KODERA<sup>\*)</sup>

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KEII and the present author<sup>1)</sup> have theoretically calculated the electrolytic separation factor, *S*, of deuterium on the basis of the slow discharge mechanism

\*) Department of Chemistry, Faculty of Science, Hokkaido University.