

NO. 1

Year 2023	<b>Summary of Thesis</b>	
Student No.	Last name, First name	
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(Title) Effect of surface treatment of catalysts on the degradation of organic dye with porous carbon catalysts and persulfate		
<p><b>1. Introduction</b></p> <p>Removal and conversion of organic pollutants in water are remaining subjects. A promising idea for the water treatment is usage of porous carbons as catalyst. Porous carbons are suitable for catalytic materials because their catalytic reactivity and large specific surface area. It has been reported that the porous carbon surface results in oxidative decomposition of organic substances in water under the presence of peroxymonosulfate<sup>[1]</sup>. However, effects of pore size and surface modification of the catalysts on the degradation efficiency are still unclear. In this study, the effects of pore structure and UV/O<sub>3</sub> treatment of porous carbon catalysts on the persulfate-driven pollutant degradation were investigated.</p> <p><b>2. Materials and methods</b></p> <p>Porous carbon (CNovel<sup>®</sup>, Toyo Tanso Co., Ltd.) with pore diameters of 10 nm, 30 nm, and 150 nm, respectively, were used. Rhodamine B (RhB) and potassium persulfate (K<sub>2</sub>S<sub>2</sub>O<sub>8</sub>) were used as model organic pollutant and oxidant, respectively. Each porous carbon and K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> were added to RhB aqueous solution, and it was then stirred using an isothermal shaking bath (300 min, 25 °C). The solution was sampled at predetermined time intervals and the RhB concentration was determined from its absorbance measured with a UV-visible spectrophotometer. Time-courses of the RhB concentration observed under the different conditions were compared: (1) addition of K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> only, (2) addition of porous carbon only, and (3) addition of porous carbon + K<sub>2</sub>S<sub>2</sub>O<sub>8</sub>. These observations were also carried out in the same manner using porous carbon treated with UV/O<sub>3</sub> for 10 min or 60 min. The determination of acidic functional groups on the sample surface was examined by Boehm titration. Elemental composition and surface pore structure of the carbon catalysts were evaluated by X-ray</p>		

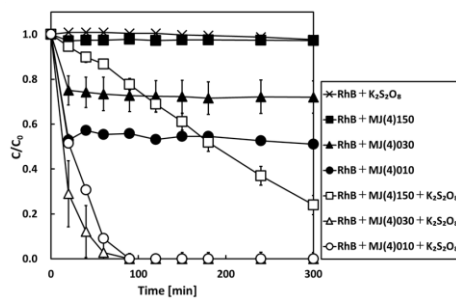
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photoelectron spectroscopy (XPS) and nitrogen sorption measurement, respectively.

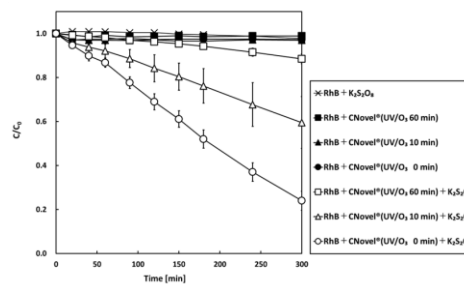
### 3. Results and discussion

Fig. 1 shows the change in concentration of RhB under various conditions. No significant decrease in concentration was observed when only  $K_2S_2O_8$  was added. RhB concentration decrease through physical adsorption was observed when only porous carbon was used. Usage of porous carbon +  $K_2S_2O_8$  resulted in the significant concentration decrease, indicating that catalytic decomposition of RhB occurred in this case. Usage of the porous carbon with larger specific surface area resulted in the marked decrease in the RhB concentration through both adsorption and decomposition.

Fig. 2 shows the concentration change of RhB measured using UV/ $O_3$ -treated porous carbon (pore size: 150 nm). Prolonged UV/ $O_3$  treatment of carbon catalysts leads to suppression of the RhB decomposition. A previous study has shown that the increase in acidic functional groups of porous carbon surface decreased basic functional groups<sup>[2]</sup>. The basic functional groups are considered to be active sites for generation of reactive species. Thus, the introduction of acidic moieties on the porous carbon surface through ozonation lowers its catalytic activity. Retention and/or introduction of the basic surface group will hence be necessary to improve the RhB decomposition rate.



**Fig.1** Time-course of the RhB concentration observed under different reaction conditions.  $C_0$  and  $C$  are the initial RhB concentration and the RhB concentration observed during the adsorption or catalytic decomposition, respectively.



**Fig.2** Time-course of the RhB concentration observed using porous carbons before and after UV/ $O_3$  treatment.

### References

- [1] M.R. Azhar et al., *ACS ES&T Water*, **1** (2021) 145.  
 [2] H. Valdes et al., *Langmuir*, **18** (2002) 2111.

### Acknowledgment

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