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Preparation of (Cr,Ti)-containing Mesoporous Silica Photocatalyst Using a Photo-assisted Deposition Method

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Introduction

It is vital to develop the photocatalysts which can operate efficiently under visible light irradiation with high selectivity. In this study, the (Cr, Ti)-binary oxide containing mesoporous silica photocatalyst was prepared by the application of a photo-assisted deposition (PAD) method which can realize the direct interaction between Cr-oxide and Ti-oxide moieties. The photocatalytic reactivity of (Cr, Ti)-containing mesoporous silica under visible light irradiation for the epoxidation of propene with oxygen has been investigated [1, 2].

Experimental

Ti or Cr - containing hexagonal mesoporous silica (Ti-HMS, Cr-HMS) were synthesized by the sol-gel method. (Cr, Ti)-binary oxide containing mesoporous silica, PAD.Cr/Ti-HMS was prepared by using a photo-assisted deposition (PAD) method; Cr-oxide was deposited on Ti – HMS from aqueous solution of $Cr(NO)_3$ under UV light irradiation ($\lambda > 220$ nm) for 24 hours. The sample was treated in centrifuge and dried before calcined at 823 K.

The photocatalytic oxidation of propene with oxygen under visible light ($\lambda > 450$ nm) and UV light ($\lambda > 220$ nm) irradiation was carried out at 273 K for 2 hours.

Results and Discussion

Fig. 1 shows the XANES spectra of reference compounds, Ti-HMS, Cr-HMS and PAD.Cr/Ti-HMS at Ti K-edge and Cr K-edge. Compared with the reference compounds, it is confirmed that the tetrahedrally coordinated Ti-oxide and Cr-oxide moieties have been formed on PAD.Cr/Ti-HMS. In Fig. 1, the intensity of preedge peak of PAD.Cr/Ti-HMS at Ti K-edge decreased after the application of the PAD method. It indicates the direct interaction between Ti-oxide and Cr-oxide moieties. Scheme 1. shows the formation of (Cr, Ti)-binary oxide moieties with direct interaction.

In photocatalytic oxidation of propene with oxygen under light irradiation, PAD.Cr/Ti-HMS exhibited activity under visible light ($\lambda > 450$ nm) irradiation and the reaction proceeded with high selectivity for partial oxidation. (Table 1).

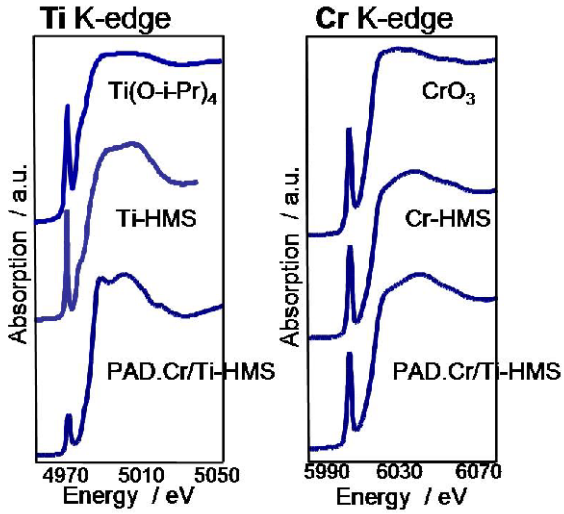
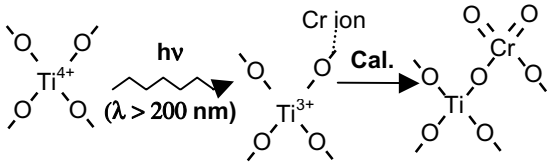


Fig. 1. XANES spectra of reference compounds, Ti-HMS, Cr-HMS and PAD.Cr/Ti-HMS at Ti K-edge and Cr K-edge.



Scheme 1. Design of (Cr,Ti)-binary oxide by photo-assisted deposition (PAD) method.

Table 1. Products distribution of propene oxidation with oxygen on various catalysts under light irradiation.

Catalysts	λ	Conv. / %	Selectivity / %				
			PO	AC	AL	AA	CO_x
Ti-HMS	UV	50	30	36	10	10	24
Ti-HMS	Visible	0	-	-	-	-	-
PAD.Cr/Ti-HMS	**Visible**	**40**	**6**	**3**	**7**	**19**	**65**

PO; propylene oxide, AC; acetone, AL; acrolein, AA; acetaldehyde, CO_x; CO + CO_2

References

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