Control of Surface Inhomogeneity and its Catalytic Properties.

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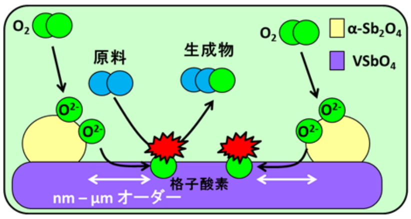
High-performance catalysts are often composed of two or more active phases, which are believed to interact with each other at the mesoscopic scale structure. Unlike conventional powder catalysts flat surfaces is advantageous in that its surface structure can be precisely designed. We prepared precisely designed $Sb_2O_4/VSbO_4/Si$ catalysts containing Sb_2O_4 ribbons with finely controlled width and separation by electron lithography(1). We demonstrated that the acrolein generation rate on the catalysts was related to the width and separation of the Sb_2O_4 ribbons. This work shows the possibility to regulate catalysis by inhomogeneity of the surface structure at the mesoscopic level.

Introduction

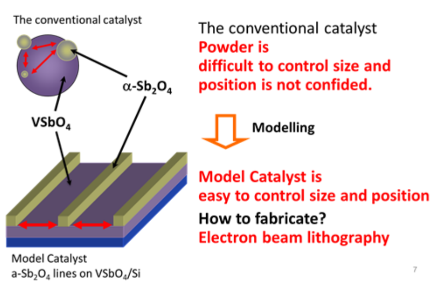


Delmon, B. Catalysis Reviews-Science And Engineering 38, 69-100 (1996).

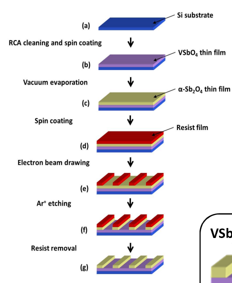
Remote Control Mechanism

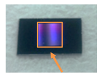
Delmon, B.; Froment, G. F. Catal. Rev. 1996, 38, 69.

Motivation



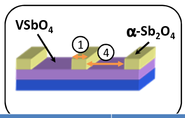
Experimental





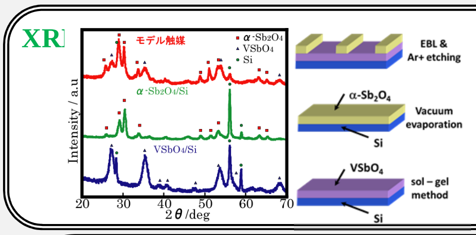
6 mm x 6 mm = 36 mm²

Haraguchi, Y., Wada, T., Ominami, Y., Matsuoka, N., Ariga, H., Takakusagi, S, Asakura, K. , *Hyomen Kagaku* **33,** 426-430 (2012).

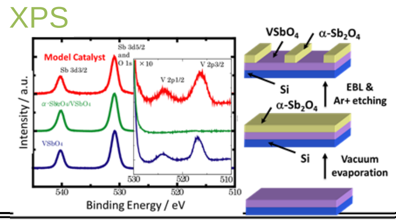


Sample	α-Sb_2O_4 linewidth` m,① /µm	$VSbO_4$ separation n,②/µm
1 µm	0.25	1
2 µm	0.5	2
4 µm	1	4
16 µm	4	16
32 µm	8	32

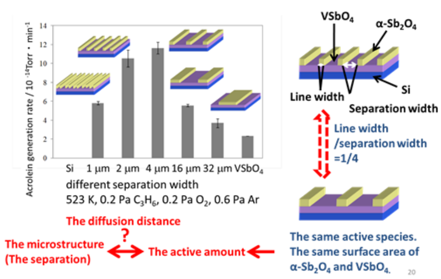
XRD



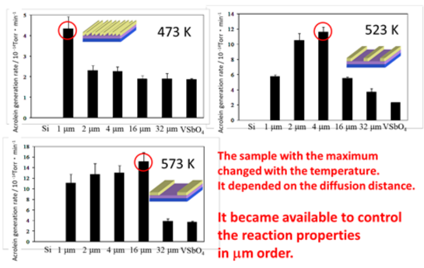
XPS



Reaction rate was related to the microstructure



Reaction rate trend varied with the temperature



The sample with the maximum changed with the temperature.
It depended on the diffusion distance.

It became available to control the reaction properties in µm order.

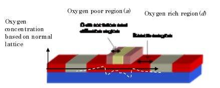


Figure 3 Proposed reaction mechanism based on the surface diffusion model in which separation is larger than the diffusion distance. The white lines represent proposed oxygen concentration.

$$r \propto a * d * N$$

$N = \frac{CL}{m+n} = \frac{CL}{5m}$ n=4m

$r \propto a * d * N = a * d * \frac{CL}{5m}$ 2a<m、2d<n

$r \propto \frac{m}{2} * d * N = d * \frac{CL}{10}$ 2a>m

$r \propto \frac{m}{2} * \frac{n}{2} * N = n * \frac{CL}{20}$ 2d>n

In this work, we demonstrated the feasibility of controlling and tuning the reaction properties of α-$Sb_2O_4/VSbO_4/Si$ samples by adjusting the Sb_2O_4 ribbon width and separation on the mesoscopic scale. Lithography is an attractive method to fabricate catalysts with precisely designed mesoscopic structure and it will lead to a new catalyst preparation methods that involve computer-controlled design and manufacture.

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Reference：Huang, H. H.; Wada, T.; Ariga, H.; Takakusagi, S.; Asakura, K.; Iwasawa, Y. *Chem. Phys.Lett.* ***2017, 683, 18.***