

Visible-light high-activity titania from catalytic and surface abatement of aromatic hydrocarbons

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Introduction

The abatement of aromatic hydrocarbons (AHC), well-known carcinogens mainly coming from car exhausts, is imperative in modern towns. It is known that the photocatalytic activity of titania anatase added to cement materials can help in the abatement of NO_x and VOC [1]. An improvement of the activity of the presently available anatase products, in particular in the visible region, is absolutely indispensable. We have therefore investigated how to increase at the same time the abatement of both NO_x and AHC over anatase.

Experimental

Adsorption and mineralization of ethylbenzene (EB) have been investigated on several commercial anatase powders. An irradiated flow-through microreactor was used for the photoactivity tests in the place of the usual chambers where gas-phase diffusion strongly impairs the activity data. Gas analysis was performed by GC. The same equipment was used for NO oxidation with the addition of a NO_x analyzer.

Results and discussion

Extensive EB adsorption, proportional to the BET surface area, occurs on anatase even in the dark, giving a significative contribution to the abatement of AHC. Under UV irradiation part of the adsorbed EB is mineralized. The reaction rate was found to be proportional to the mesopore surface area, while the micropores appear to be ineffective. During the irradiation test the anatase powder progressively darkens due to the formation of carbonaceous deposits, as confirmed by TPO test. It is reasonable that extensive cracking of EB occurs on anatase acid sites under UV irradiation.

As anatase shows very small activity under irradiation in the visible region, many researchers tried to increase it by addition of various atoms as promoters in the structure of anatase [2], but with contradictory results. The insertion of carbon atoms was tried too [3]. We have checked that C insertion obtained by precipitation of Ti hydroxide together with organic compounds and subsequent calcination was ineffective for NO oxidation. Conversely anatase samples having worked few hours for EB abatement develop a high activity for NO_x abatement under visible light. That means that surface doping with carbon atoms or more in general with carbonaceous species is able to increase the photocatalytic activity of anatase for NO oxidation, with possible subsequent interaction of NO₂ with such species. The presence of this surface promotion allows to infer that C atoms embedded in the structure of anatase [4] are not indispensable for its activity increase under visible light.

Conclusions

It has been found that for anatase showing high activity in AHC abatement a high mesopore surface area is indispensable. It should preferably overcome 200 m²/g.

It is noteworthy that during AHC abatement the anatase surface strongly increases its activity for NO_x abatement too, due to catalytic promotion by surface carbon species, a curious example of self-promotion coming from performing a different catalytic reaction.

References

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