Study on Functional Catalysts for Energy Conversion and Environmental Protection

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（エネルギー変換と環境保全を指向した機能触媒に関する研究）

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論 文 内 容 の 要 旨

Thesis Summary

Faced with environmental pollution and energy crisis, human society should find novel technologies to solve these problems. Recently, photocatalytic process and microwave heating process have attracted many attentions due to the low cost, environmentally friendly, and energy saving. However, these technologies need effective catalysts. Thus, the aim of this thesis is to improve the photocatalytic and microwave heating catalytic properties of titanium dioxide and zinc sulfide catalysts, mainly based on the material compositing, noble metal depositing and metal ions doping. The main research contents and results are as follows:

(1) The synthesis and photocatalytic oxidation process of Ti^{3+} self-doped TiO_2 microspheres were systematically studied. This Ti^{3+} doped TiO_2 photocatalyst is consisted of uniform microspheres and can possess a high activity for photocatalytic benzene oxidation. Moreover, through a series of characterization, we found that the enhanced photocatalytic activity is attributed to the doping Ti^{3+} ions, which can narrow the bandgap to utilize more light and suppress the formation of byproducts during the photocatalytic oxidation process.

(2) The Pt/TiO_2 microspheres were successfully synthesized via simple methods. From the testing results, the size of Pt/TiO_2 microspheres was around 250 nm with 2-3 nm Pt nanoparticles deposited. The Pt/TiO_2 microsphere shown high catalytic activity in benzene oxidation than that of other types of noble metal catalyst-supported catalysts in traditional thermal catalytic reaction. Moreover, When combine Pt/TiO_2 microspheres with active carbon, the composite catalysts exhibited higher activity for complete oxidation of benzene under microwave heating than normal outer heating. This is because the microwave heating process can effectively increase the activated molecules and reduce the activation energy of reaction

(3) The Cu-doped ZnS nanospheres were firstly synthesized by chemical and solvent method. The optical properties of ZnS can be easily affected by doping Cu ions, and Cu ions can make ZnS shown the photocatalytic H_2 production under visible light. In order to further improve the activity, Cu-doped ZnS nanospheres were combined with MoS_2 nanosheets. Under visible light irradiation, the H_2 production rate of the composite of MoS_2/Cu-doped ZnS were 2.2 times higher than that of bare Cu-doped ZnS. This is because the MoS_2 can improved the ability of separating redox sites and absorbing more light.