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1. Main Research Results

Photocatalytic Reduction of CO_2 with Oxide Photocatalyst

Converting of greenhouse gas CO_2 into useful hydrocarbon fuel by photocatalytic reaction is expected as an ultimate technology to solve the global warming problem. However, the conversion efficiency is still very low, because reduction of CO_2 needs a good adsorption property of the material to CO_2, a very strong reduction potential, a multi-electron reaction process, etc. In this study, we have developed a simple ion exchange method for synthesis of micro/mesoporous Zn_2GeO_4 with crystalline pore-walls at room temperature. Such prepared mesoporous Zn_2GeO_4 showed 6 times higher photoactivity for converting CO_2 into CH_4 fuel in contrast to the sample prepared by solid state route, since large specific surface area of the mesoporous photocatalyst are beneficial to CO_2 capture and conversion. In addition, the evolution rate of CH_4 over micro/mesoporous Zn_2GeO_4 could be significantly enhanced by loading Pt as co-catalyst, because the co-catalyst promotes the multi-electron reaction process which benefits the CO_2 photoreduction.

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② S. C. Yan, S. X. Ouyang, J. Gao, M. Yang, J. Y. Feng, X. X. Fan, L. J. Wan, Z. S. Li, J. H. Ye, Y. Zhou and Z. G. Zou. "A Room-Temperature Reactive Template Route to Mesoporous $ZnGa_2O_4$ with Improved Photocatalytic Activity in Reduction of CO_2", *Angew. Chemie*, 49, 6400-6404, 2010.

2. List of Publications:

1) Ning Zhang, Shuxin Ouyang, Peng Li, Yuanjian Zhang, Guangcheng Xi, Tetsuya Kako, and Jinhua Ye, “Ion-Exchange Synthesis of Micro/Mesoporous Zn_2GeO_4 Photocatalyst at Room Temperature for Photoreduction of CO_2“, *Chem. Commun. 47*, 2041-2043, 2011.

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12) Guangcheng Xi and Jinhua Ye, "Synthesis of Hierarchical Macro-/Mesoporous Solid Solution Photocatalysts by a Polymerization-Carbonization-Oxidation route: The case of $Ce_{0.49}Zr_{0.37}Bi_{0.14}O_{1.93}$", *Chem. Eur. J*, **16**, 8719-8725, 2010.
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3. Conference Presentations (International & Domestic)

Invited talks

1) Jinhua Ye, Nano Photocatalytic Materials: possibilities & challenges、Australia-China symposium on nanomaterials for clean energy、Queensland University, Brisbane, Australia、2010/05/27 -29
2) Jinhua Ye, Nano Photocatalytic Materials: possibilities & challenges、1st International Conference on Materials for Energy、DECHEMA Congress Office Karlsruhe Convention Center, Karlsruhe, Germany、2010/07/04 – 08
3) Jinhua Ye, Zhiguo Yi、Tetsuya Kako、New Visible Light Active Photocatalyst Ag3PO4、10^{th} Meeting of Photo Functionalized Materials Society, Research Center for Advanced Science and Technology, Tokyo, Japan、2010/07/14
4) Jinhua Ye, Zhiguo Yi、Tetsuya Kako、Naoki Kikugaw、Shuxin Ouyang, Naoto Umezawa, Zhigang Zou, Nano Photocatalysts for Solar Chemical Conversion and Environmental Remediation、IUMRS-ICA2010、International Union of Materials Research Societies、Qingdao International Convention Center, Qingdao, China, 2010/09/25 – 28
5) Naoto Umezawa, Shuxin Ouyang, Jinhua Ye, Theoretical study of an excellent photocatalyst Ag3PO4、IUMRS-ICA2010、International Union of Materials Research Societies、Qingdao International Convention Center, Qingdao, China, 2010/09/25 – 28
6) Kikugawa Naoki, Zhiguo Yi, Tetsuya Kako, Shuxin Ouyang, Junyu Cao, Naoto Umezawa, Jinhua Ye, Photo-induced Oxidization Properties of a Silver Orthophosphate under
   Visible-light Irradiation、4th International Workshop on Advanced Ceramics、Nagoya Institute of Technology（Nagoya, Aichi）, 2010/12/10-12

Oral Presentation

7) Naoto Umezawa, Jinhua Ye, EFFECTS OF LOADING MULTIVALENT OXIDES ON PHOTOCATALYSTS、18th International Conference on Photochemical Conversion and Storage of Solar Energy（IPS-18）、Korea University, Seoul, Korea、2010/07/25 - 30
8) Zhiguo Yi, Shuxin Ouyang, Naoto Kikugawa, Tetsuya kako, Jinhua Ye, Highly Effective O2 Evolution over a Novel Photocatalyst Ag3PO4 under Visible-light Irradiation、National Conference on Solar Energy Photochemistry and Photocatalysis、Photochemical Professional Committee of Chinese Renewable Energy、University of Yunnan, Kunming, China, 2010/08/05-06

9) Yingpu Bi, Jinhua Ye, Facile synthesis of one-dimensional metal/semiconductor hetero-nanostructures and their catalytic properties、National Conference on Solar Energy Photochemistry and Photocatalysis 、 Photochemical Professional Committee of Chinese Renewable Energy、 University of Yunnan, Kunming, China, 2010/08/05-06
10) Tetsuya Kako, Jinhua Ye, Degradation of ethanal by ilmenite- and pyrochlore-structured silver antimonate photocatalysis 、 Pachifichem 2010 、 Convention center in Hawaii, Honolulu, USA、 2010/12/15-20
11) ZHANG Yuanjian, Toshiyuki Mori, Jinhua Ye, Markus Antonietti、Photovoltaic systembased on polymeric carbon nitride solids、 Pachifichem 2010、Convention center in Hawaii, Honolulu, USA、 2010/12/15-20
12) Tetsuya Kako, Qiuye LI, and Jinhua Ye, hotophysical and Photocatalytic Properties of Ti-based Oxides, The 4th Japan-China Symposium on Advanced Photocatalytic Materials, Urabanndai, Fukushima, 2011/1/20-22
13) Hua Tong, Naoto Umezawa and Jinhua Ye, Electronic Coupling Assembly of Titanium Oxide Nanocrystals: Self-Narrowed Band Gap and Photocatalytic Application, The 4th Japan-China Symposium on Advanced Photocatalytic Materials, Urabanndai, Fukushima, 2011/1/20-22
14) Mitsutake Oshikiri, M. Boero, A. Matsushita, and Jinhua Ye, Water Molecule Dynamics at around the Co-catalyst Ni Oxide at the Surface of Metal Oxide Photo-catalyst, The 4th Japan-China Symposium on Advanced Photocatalytic Materials, Urabanndai, Fukushima, 2011/1/20-22
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20) Tetsuya Kako, Qiuye Li, Jinhua Ye, Photocatalytic and Photophysical Properties of Titanium Oxide, Japan Chemical Society Annual Meeting 2011, Japan Chemical Society, University of Kanagawa, Yokohama, Kanagawa、 2011/03/26-29

Poster Presentation

21) Bing Yue, Tetsuya Kako, Jinhua Ye, Zinc Containing Carbon Nitride hybrid Materials as a Novel Photocatalysts for Hydrogen Evolution with Visible Light、4th Int. Conf. on the Science & Tech. for Advanced Ceramics(STAC-4)、Mielparque Yokohama、 2010/06/21 – 23
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24) Naoto Umezawa, Shuxin Ouyang, Jinhua Ye, High photocatalytic activity of Ag3PO4 from first-principles calculations、The 17th Symposium of Photo Functionalized Materials Society, KSP Hall, Kanagawa Science Park, Kanagawa 2010/12/02
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Conversion Efficiency of WO3 Photoanodes Based on 3D-Photonic Crystal Design、The 17th Symposium of Photo Functionalized Materials Society, KSP Hall, Kanagawa Science Park, Kanagawa、2010/12/02

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33) Zhiguo Yi, Jinhua Ye, and Ray L Withers、Materials Design towards Solar-driven Water Splitting, NIMS International Symposium on Photocatalysis and Environmental Remediation Materials 2011, NIMS, Tsukuba, 2011/1/17-19
34) Junyu Cao, Tetsuya Kako, Naoki Kikugawa, Jinhua Ye, Photoelectrochemical property of Fe2O3 electrode for water splitting, NIMS International Symposium on Photocatalysis and Environmental Remediation Materials 2011, The 4th Japan-China Symposium on Advanced Photocatalytic Materials, Urabanndai, Fukushima, 2011/1/20-22
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4. International Collaborations:

1) A new MEMORANDUM OF COLLABORATION was signed between the School of Materials Science and Engineering, Tianjin University, and Photocatalytic Materials Centre, NIMS, on field of “Advanced Photofunctional Materials for Solar Energy Conversion and Environment Remediation”.

2) A new MEMORANDUM OF COLLABORATION was signed between the Department of Chemical Engineering, University College London, and the Photocatalytic Materials Centre, NIMS, in the areas of research, education and training in the field of Renewable Energy Production.
3) Collaborate with Nanjing Univ., China, on “Research on solar energy conversion and environmental purification materials”. Exchanges of researchers (including graduate school students), exchanges of research information and promotion of joint research programs were actively conducted.
4) Collaborate with The University of Queensland, Australia, on “Research and Development of Photocatalysis Materials for CO2 reduction and conversion”. Exchanges of researchers (including graduate school students), exchanges of research information and promotion of joint research programs were actively

conducted.

5. Others

Organized the NIMS International Symposium on Photocatalysis and Environmental Remediation Materials 2011 （Jan.17-19， NIMS, Tsukuba, Japan), and the 4th Japan-China Joint Symposium on Advanced Photocatalytic Materials (Jan. 20-22, at the Conference Hall of Urabandai Nekoma Hotel, Fukushima, Japan)