High Speed Reaction Field of Stable/Metastable Bulks Mixed in Nano-Scale and Its Applications

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【Outline of survey】

Ce-complex oxides with dispersed Pt are well known as an efficient reaction field for automotive exhaust gases. Oxygen transport between stable $Ce^{3+}{}_2Zr^{4+}{}_2O_7$(pyrochlore phase) and oxygen-intercalated metastable $Ce^{4+}{}_2Zr^{4+}{}_2O_8$(κ phase) contributes to oxidation of HC and CO and reduction of NOx gas. The metastable κ phase decomposes around 1100℃. For Pr-oxides, there exists several CaF_2-like, stable phases, which are expressed as $Pr_nO_{2n-2}=(Pr^{3+}{}_4Pr^{4+}{}_m)O_{2(4+m)-2}$ （m=0,1,3,5,6,7,8∞. Two oxygen ions are removed from total oxygen sites twice than cations. m=4 corresponds to $Ce^{3+}{}_4Zr^{4+}{}_4O_{14}=Ce^{3+}{}_2Zr^{4+}{}_2O_7$ pyrochlore. Assembly of rare-earth ion with 3+ and metal ions with 4+ may lead to various several CaF_2-like stable phases and also oxygen-intercalated metastable-phases. In this project, various resembled CaF_2-like stable and metastable phases are mixed in nano-scale to control the interface energy. The stable/metastable phases should become virtually stable at higher than 1300℃, and make possible high-speed oxygen transfer even at low temperature as 300℃.

【Expected results】

Several noble complex oxides containing rare-earth elements may be detected. Dream of efficient reaction field, working at low temperature as 300℃, and being stable even at 1300℃, without addition of Pt, may come true. To control stable/ metastable nano-space leads to various speed and quantity of oxidation-reduction reaction. This property can be applied to hydrogen production via C_nH_{2n+2} and H_2O, baiomass and H_2O, and also selective oxidation of CO in H_2+CO gases.

【References by the principal investigator】

・“Synthesis of Novel Cation-Ordered Compounds with Fluorite Related Structure Prepared by Oxidation of Sn-Ta-O pyrochlore”, **J. Solid State Chem. 178**, 1254-1261(2005).

・“Vibrational spectroscopic and X-ray diffraction studies of cerium zirconium oxides with Ce/Zr composition ratio=1 prepared by reduction and successive oxidation of t’-$(Ce_{0.5}Zr_{0.5})O_2$ phase”, **J. Solid State Chem. 147**,573-583(1999).

【Term of project】 FY2007－2011	【Budget allocation】 32,400,000 yen (2007 direct cost)

【Homepage address】 http://www.mat.eng.osaka-u.ac.jp/msp4/MSP4-HomeJ.htm