Project report

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Combined *in situ* XANES, XRD and MS study of the decomposition of CO_2 on ferrites

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Reduced ferrites can efficiently decompose CO_2 to carbon with little or no formation of CO at low temperatures (~ 300°C)[1,2]. In this project, the CO_2 decomposition was carried out at higher temperatures (500°C) to study the reaction mechanism and the structural changes of the ferrites during reduction in hydrogen and reoxidation in CO_2. An aim to this work is to establish any catalytic activity towards CO_2 decomposition at 500°C. The structure of the materials was studied by combined *in situ* XANES and XRD, and the gaseous products were monitored by a mass spectrometer. The combination of the three techniques enables us to obtain a complete picture of the system. Different types of ferrites were used in this project ($CoFe_2O_4$, Fe_3O_4, $NiFe_2O_4$ and $ZnFe_2O_4$) to study the role of the divalent atom (Co(II), Fe(II), Ni(II) and Zn(II)) in the reaction.

For nickel ferrite, the material is completely reduced in hydrogen (5% in He) to metallic nickel and iron (Figure 1b). The reduced material is partially reoxidised (*ca*. 80%) in CO_2 (Figure 1c). The X-ray powder diffractogram shows that the reoxidised material consist of unreacted metal, Fe_3O_4 or $NiFe_2O_4$ and nickel oxide (NiO). From the analyses of the exhaust gas, none of the ferrite materials show any catalytic activity. In the reaction, CO_2 is reduced to carbon monoxide.

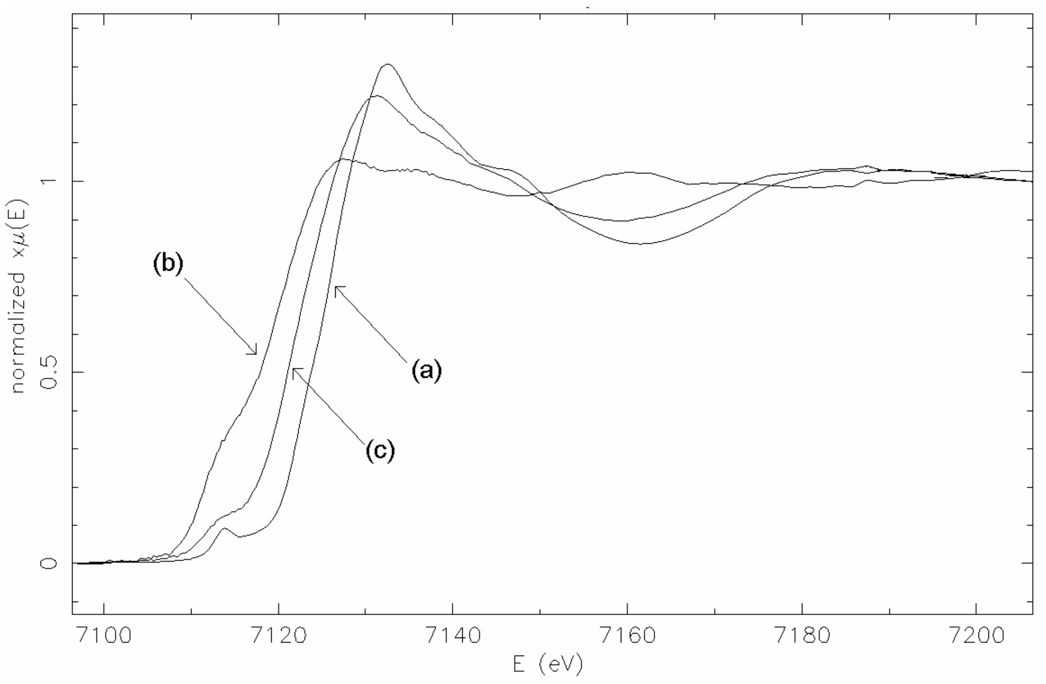

Figure 1 Normalised Fe K-edge XANES of nickel ferrite; (a) original sample, (b) after treatment in hydrogen (5%) and (c) after treatment in CO_2 (10%).

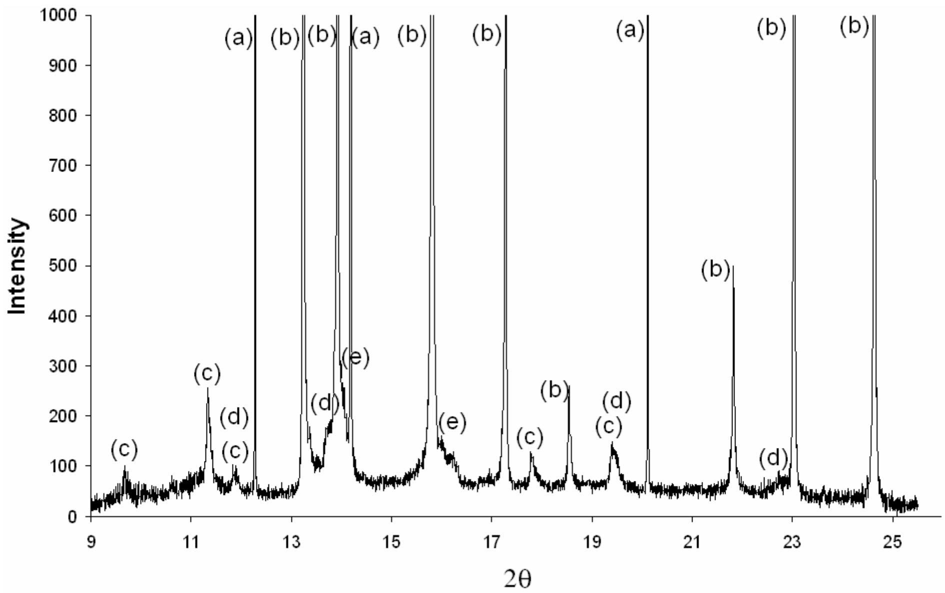

Figure 2 XRD at room temperature of nickel ferrite after treatment in CO_2 where (a) is aluminium (window) (b) boron nitride, (c) unreacted metal, (d) NiO and (e) Fe_3O_4 or $NiFe_2O_4$.

References

1. Y. Tamaura and M. Tabata, Nature, 1990, 346, 255
2. M. Tabata, K. Akanuma, K. Nishizawa, K. Mimori, T. Yoshida, M. Tsuji, Y. Tamaura, J. Mater. Sci., 1993, 28, 6753