SEM Studies of Fe_2O_3 Thin-Films on Glass Substrate

A. Turković[1], M. Ivanda[1], M. Bitenc[2], and Z. Crnjak Orel[2]

1. Institute "Ruđer Bošković", P.O.Box 180, 10002 Zagreb, Bijenička c. 54, Croatia
2. National Institute of Chemistry, SI-1001 Ljubljana, Hajdrihova 19, Slovenia

turkovic@irb.hr
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We have investigated thin-films containing nanosized grains of Fe_2O_3 and Fe_2O_3 with Li by the scanning electron microscopy (SEM), impedance spectroscopy (IS) and thermally stimulated currents (TSC) and the Raman spectroscopy. Combining these methods the dependence of structural and electrical properties upon percentage of Li added into the matrix of these metal-oxide films was found. The comparison of IS, TSC and Raman results reveals the increase of grain sizes upon inducing 1% of Li in Fe_2O_3 matrix followed by the decrease of grain sizes in the case of samples with 10% Li, as well as the decrease (increase) of conductivity, respectively. These changes are explained by the structural changes of grains (and grain boundaries) and with the impact of Li^+ ions in the charge transfers. [1].

Thin-films containing nano-sized grains of Fe_2O_3 are widely used in research into mainly magnetic and electronic devices [1-5]. Their capacity for incorporating lithium ions is important in the construction of galvanic cells of second generation [6-17].

Films of iron oxide derived by the spray method route were investigated by the impedance spectroscopy (IS), Raman spectroscopy, SEM and XRD in order to determine their electrical, structural and morphological properties. Our goal was to establish the relation between electrical and the structural properties in nano-structured Fe_2O_3 and Fe_2O_3:Li films on glass substrate.

IS was applied to measure the resistance of nano-structured Fe_2O_3 films with different contents of lithium. In our previous work [18] TSC spectra, often used in characterization of high resistive or semi-insulating (SI) materials [19, 20] were measured on the same samples, in order to investigate possible defects with deep levels in the forbidden energy gap and to see relation of it to the different percentages of Li. By Raman and XRD measurements, we have determined, besides the hematite nature of our samples, that they are composed of the nano-sized grains, which was also proved by SEM investigation. It was also found that the variation of Li content is related to the changes of the grain sizes.

1. J. Zhu, K.J. Tseng, IEEE Trans. on Magnetics. **40**(5) (2004) 3339.
2. C.N.R. Rao, G.U. Kulkarni, P.J. Thomas, V.V. Agrawal, U.K. Gautam, M. Gosh, Current Science, **65**(7) (2003) 1041.
3. L. Casas, A. Roig, E. Rodriguez, E. Molins, J. Tejada, J. Sort, J. of Non-crystalline Solids, **285**(1-3) (2001) 37.
4. T. Mizushima, A. Makino, F. Kaneko, S. Kobayashi, Mat. Trans. JIM **32**(12) (1991) 1177.
5. Z.Y. Ling, M.R. Xiong, Q.Q. Zhang, J. of Magnetism and Magnetic Materials, **219**(1) (2000) 9.
6. Y. Zhang, X.P. Gao, H.Hu, Z. Zhou, J. Yan, J.Q. Qu, F. Wu, Chinese J. of Inorg. Mat. **20**(9) (2004) 1013.

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7. T. Grygar, P. Bezdicka, D. Hradil, L. Pikna, Solid State Chemistry V Solid State Phenomena**, 90-91** (2003) 45.
8. T. Matsumura, N. Sonoyama, R. Kanno, M. Takano, Solid State Ionics, **158**(3-4) (2003) 253.
9. S. Komaba, K. Suzuki, N. Kumagai, Electrochemistry, **70**(7) (2002) 506.
10. C.W. Kwon, A. Poquet, S. Mornet, G. Campet, J. Portier, J.H. Choy, Electrochemistry Communications, **4**(2) (2002) 197.
11. W. Wong-Ng, R.S. Roth, T.A. Vanderah, H.F. McMurdie, J. of Res. Of the National Institute of Standards and Technology**, 106**(6) (2001) 1097.
12. N. Cui, J.L. Luo, Electrochimica Acta, **44**(5) (1998) 711.
13. S. Ito, k. Ui, N. Koura, K. Akashi, Solid State Ionics, **115** (1998) 17.
14. J. Sarradin, M. Ribes, A. Guessous, K. Eikacemi, Solid State Ionics, **112**(1-2) (1998) 35.
15. A. Mastral, M. J. Perez-Surio, J. Palacios, Fuel, **77**(6) (1998) 585.
16. S. Ito, K. Ui, N. Hoshi, H. Kurosawa, N. Koura, K. Akashi, J. de Physique IV, **7**(C1) (1997) 161.
17. A. Guerrero, A.Romero, R.D. Morales, F.Chavez, Canadian Journal Quaterly, **36**(2) (1997) 121.
18. A. Turković, M. Pavlović, M. Ivanda, M. Gaberšček and Z. Crnjak Orel, J.of Electrochemical Society **153** (1) (2006) A122.
19. Z.-Q. Fang, L. Shan, T. E. Schlesinger and A. G. Milnes, Mater. Sci. and Engineering B **5** (1990) 397.
20. M. Pavlović, U. V. Desnica and J. Gladić, J. Appl. Phys. **88** (8) (2000) 4563.

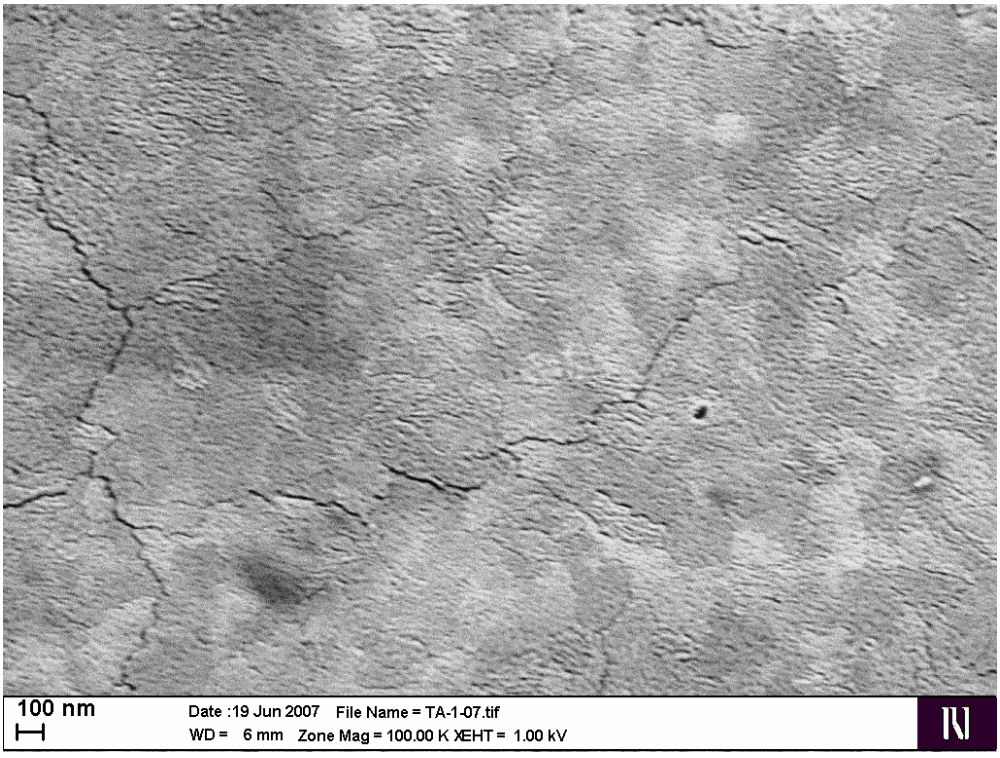

Figure 1. SEM of Fe_2O_3 film.