Tailoring of electron diffusion through TiO_2 nanowires

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ABSTRACT
Charge transport through a random network of onedimensional TiO2 nanostructures such as nanorods, nanowires, and nanofibers developed by electrospinning technique has been studied in the presence of an electrolyte by electrochemical impedance spectroscopy and transient photocurrent measurements. The results have been compared with the charge transport parameters of random TiO2 nanoparticle (25 nm) network. The charge transport was discussed under the framework of hopping transport. Continuous nanofibers had longer charge collecting times and short nanorods have enhanced scattering losses. The TiO2 films containing random network of nanowires of aspect ratio 10:1 can have an order of magnitude higher diffusion coefficient than other morphologies. Furthermore, charge transport through Nb-doped anatase TiO2 nanofibers was studied. It was observed that the Fermi level of TiO2 rise close to its conduction band and result in a band-edge type diffusion mechanism even at low bias voltages when 2 wt% Nb atoms replaces the Ti atoms in the anatase lattice. The Nb-doped anatase electrospun nanofibers showed high chemical capacitance, high effective diffusion coefficient, and lower transport resistance compared to the undoped samples and conventional nanoparticles.

KEYWORDS:
Anatase; charge transport; diffusivity; electro; spinning; Fermi level; nanowires

REFERENCES

1. Bisquert, J. Physical electrochemistry of nanostructured devices. (2008) Physical Chemistry Chemical Physics, 10 (1), pp. 49-72

2. Bisquert, J., Fabregat-Santiago, F., Mora-Seró, I., Garcia-Belmonte, G., Barea, E.M., Palomares, E. A review of recent results on electrochemical determination of the density of electronic states of nanostructured metal-oxide semiconductors and organic hole conductors. (2008) Inorganica Chimica Acta, 361 (3), pp. 684-698.

3. Monroe, D. Hopping in exponential band tails. (1985) Physical Review Letters, 54 (2), pp. 146-149.

4. Grätzel, M. Solar energy conversion by dye-sensitized photovoltaic cells. (2005) Inorganic Chemistry, 44 (20), pp. 6841-6851.

5. Jose, R., Thavasi, V., Ramakrishna, S. Metal oxides for dye-sensitized solar cells. (2009) Journal of the American Ceramic Society, 92 (2), pp. 289-301.