Synthesis and characterization of magneli phase titania powder/activated carbon composite materials for electrochemical applications

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Magneli phases titanium oxides with general formula Ti_nO_{2n-1} ($4 < n < 10$) which have been known since 1956 [1], have been considered for a wide range of electrochemical applications, such as electrowinning, batteries, fuel cells, cathodic protection, synthesis and environmental treatment [2].

The carbonic structures such as graphite, carbon nanotubes, and carbon black have been recognized as a promising material for various applications because of the low packing density, large surface area for charge transport, and high porosity for easy penetration of electrolyte, which can maintain the structures against agglomeration and degradation [3-5].

In this study, preparation procedure and characterization of composite materials (magneli titanium oxide containing sawdust-based activated carbon) is presented. For this purpose, magneli titanium oxide containing activated carbon was prepared through hydrolytic precipitation of titanium oxide from tetrapropylorthotitanate and tetrabutoxideorthotitanate following heat treatment at 500°C under flow of nitrojen.

In Fig. 1, XRD patterns of TAC1, TAC2, and TiO_2 annealed to 500°C during 1 h were shown. In spite of titanium oxide only have anatase crystal structure, for TAC1 and TAC2, new phases of Ti_3O_5, Ti_4O_7 and Ti_9O_{17} appeared. Especially for TAC1, peaks of new phases were sharpened. This related to containing of activated carbon in composite structure. Rutile structure was not indicated for all samples.

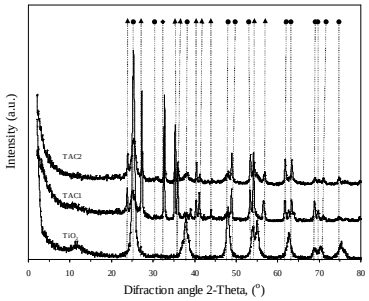

Fig. 1 X-ray diffractions patterns for TAC1, TAC2 composites and TiO_2

SEM micrographs of TiO_2, TAC1 and TAC2 are shown in Fig. 2. The composite materials looked black, due to the carbonization of sawdust, though the original hydrolysis products of $Ti(OPr^n)_4$ and $Ti(OBu^n)_4$ was kept white after heating at the same temperature. Additionally, it was observed that aggregated of titanium particles between carbon layers.

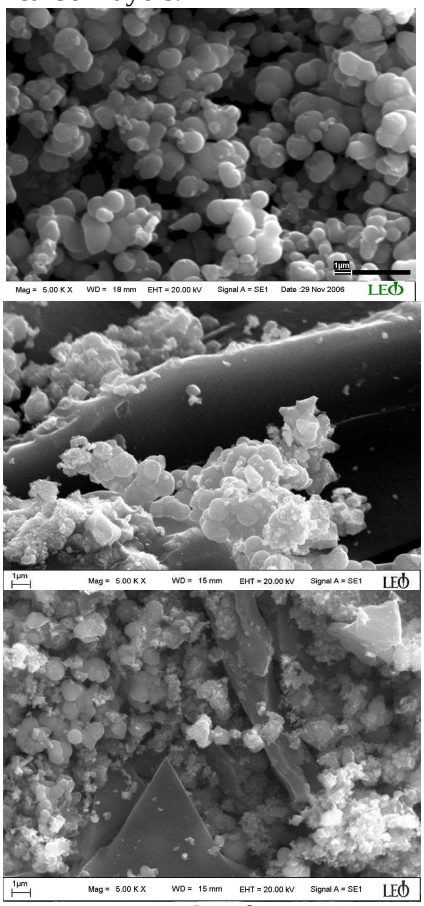

Fig. 2 SEM micrographs of TiO_2 (a), TAC1 (b) and TAC2 (c) composite material

References

[1] S. Andersson, A. Magneli, Naturwiss 43, 495, 1956.
[2] F.C. Walsh, R.G.A. Wills, Electrochimica Acta 55 (2010) 6342¯6351.
[3] K. Saravanan, K. Ananthanarayanan, P. Balaya. Energy Environ Sci 3(7), 939¯948, 2010.
[4] Liang CD, Li ZJ, Dai S. Angew Chem Int Ed. 47(20), 3696¯3717, 2008.
[5] Huang CH, Doong RA, Gu D, Zhao DY. Carbon 49(9), 3055¯3064, 2011.