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Green synthesized carbon material as a photocathode in dye sensitized solar cells

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[Introduction]

Carbon is one of the interesting material for researchers in the last few decades due to its manifold properties. The catalytic nature with chemical stability were attracting in many fields such as fuel cells, super capacitors and so on. It has been extensively investigated as a photopcathode for dye sensitized solar cells [1,2]. Synthesizing carbon materials, staring from the nanostructures it involves complicated procedures and high cost finds less importance towards the commercial applications [3]. In order to utilize the best properties of carbon materials, a cost effective synthesis method is needed. In the present work, we report a green synthesis of carbon material from the organic wastes, such as corn cob and lemon peel were investigated. One step synthesis process was carried out by chemical method. Synthesized carbon materials have been characterized by FESEM, XRD, Raman, FTIR and EDAX analysis. Carbon materials were used to prepare the photocathode of DSSC and the device characteristic was obtained using P-25 TiO_2 as a photo anode and N-719 dye as a sensitizer.

[Experimental method]

Corn cob and lemon peel carbon synthesis method: 50 wt % of Phosphoric acid and corn cob of 10 g were stirred for 3 hours at 120 ˚C. Residues of the filtrate were sintered at 500 °C in argon atmosphere. The final powder was washed with distilled water several times to maintain the pH in the range of 6 to 7. The same procedure was followed, but instead of corrosive acid, potassium hydroxide of 1:1 ratio was taken with the source material. The reaction temperature increased to 700 ˚C. The photocathode of DSSC was prepared by spray pyrolysis technique for both the carbon materials. 250 milligrams of carbon material were dispersed in 50 ml of ethanol and 0.3 ml of triton –X was added as an organic binder. The solution was sprayed on the FTO substrate at the substrate temperature of 150 ˚C and it was annealed at 450 ˚C for 2 hrs. The photoanode was fabricated by using P-25 commercial TiO_2 nanopowder. Prepared photo anodes were immersed into N-719 Ruthenium based dye for 12 hours.

[Results and discussion]

Figure 1 (a) and (b) shows the FESEM images of corn cob carbon and lemon peel carbon. It can be clearly seen that, derived carbon from the wastes of organics contained different size ranges of pores. Pore structure leads to high surface area material. From the other characterizations such as XRD and Raman confirms the nature of carbon was related to the graphitic based structure. FTIR of the carbon materials from corn cob and lemon peel explains the presence of C-C aromatic vibrations. Elemental analysis was used to quantify the carbon material of organic wastes. More than 80% of materials were related to carbon. Further the I-V characteristic was analyzed with photo cathodes of corn cob carbon and lemon peel carbon, along with commercial platinum electrode were used to compare the results. Corn cob carbon shows 5.36 % efficiency and lemon peel carbon has 1.65%. The observed efficiency of corn cob carbon was almost equal to the platinum based electrode.

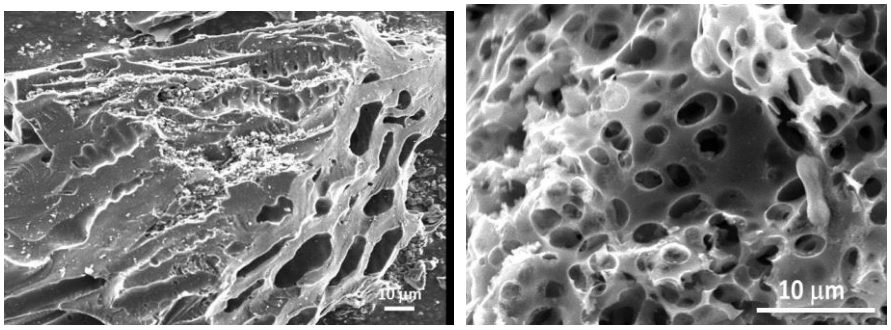

Figure 1: FESEM images of (a) Corn cob carbon, (b) Lemon peel carbon

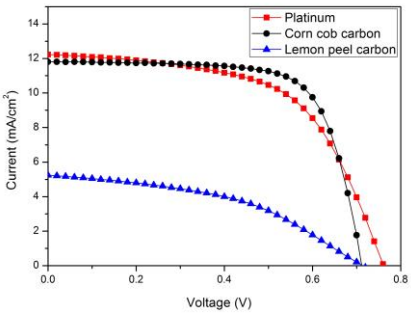

Figure 2: I-V curves of DSSC.

[References]

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2. Yiming Chen et.al, J. of Nanomaterials, 601736, 6 (2012).
3. Sungjin park et al, Nature Nanotechnology, 2009, 58.