Low-cost, Green and Stable Metal Oxide Semiconductors and Transparent Flexible Electrode for High Performance Optoelectronic Devices

Wallace C. H. Choy

Department of Electrical and Electronic Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong.
E-mail: chchoy@eee.hku.hk

While high temperature evaporation and sputtering are commonly used for forming metal oxide semiconductors, we will discuss our room-temperature solution approaches for forming various metal oxides. To demonstrate their good electron and hole transport properties, we will use them for all solution-procesed organic/inorganic optoelectronics such as organic solar cells (OSCs), perovskite solar cells, dye sensitized solar cells, organic light emitting diodes, etc which can favor the efficient transport of carriers between the photoactive layer and electrode as well as high optical transparency. Transition metal oxides are promising materials for carrier transport layers because of their good electrical properties, stability, and optical transmission. We propose and demonstrate several low-temperature solution-processed approaches for forming transparent and efficient metal oxide-based carrier transport layers including electron and hole transport layers [1-6]. With the incorporation of metal nanoparticles [7-9], the electrical and optical properties can be enhanced. The interesting features of the novel carrier extraction layers are low temperature, solution process and water free for high performance optoelectronics such as OSCs with power conversion efficiency (PCE) of 10.5% [10]. In addition, we have developed some room-temperature processed Ag nano-network which can serve as transparent flexible electrodes [11]. With the knowledge of solution processed organic and inorganic materials, we also propose different approaches for highly stable and efficient perovskite SCs with PCE of 17.5% and no hysteresis [12].

References

[1] F. Jiang, W.C.H. Choy, X. Li, D. Zhang, J. Cheng, *Adv. Mat.*, 27, 2930, 2015.
[2] F. Xie, W.C.H. Choy, C. Wang, X. Li, S. Zhang, J. Hou, *Adv. Mat.*, 25, 2051, 2013.
[3] X.C. Li, F.X. Xie, S.Q. Zhang, J.H. Hou, W.C.H. Choy, *Light: Sci. & Applications*, doi:10.1038/lsa.2015.46.
[4] S. Lu, X. Guan, X. Li, W.E.I Sha, F.X. Xie, H. Liu, J. Wang, F. Huang, W.C.H. Choy, *Adv. Energy Mat.*, DOI: 10.1002/aenm.201500631.
[5] X.C. Li, F.X. Xie, S.Q. Zhang, J.H. Hou, W.C.H. Choy, *Adv. Function. Mat.*, 24, 7348, 2014.
[6] F.X. Xie, S.J. Cherng, S. Lu, Y.H. Chang, W.E.I. Sha, S.P. Feng, C.M. Chen, W.C.H. Choy, *ACS Appl. Mat. & Interfaces*, 6, 5367, 2014.
[7] D. Zhang, W.C.H. Choy, F.X. Xie, X. Li, *Org. Electron*, 13 2042, 2012.
[8] F.X. Xie, W.C.H. Choy, W.E.I. Sha, D. Zhang, S. Zhang, X. Li, C.W. Leung, *J. Hou, Energy Environ. Sci.*, 6, 3372, 2013.
[9] D. Zhang, W.C.H. Choy, F. Xie, W.E.I. Sha, X. Li, et al, *Adv. Funct. Mat.*, 23, 4255, 2013.
[10] D. Zhang, F. Xie, P. Lin, W.C.H. Choy, *ACS Nano*, 7, 1740, 2013.
[11] X.C. Li, W.C.H. Choy, F. Xie, S. Zhang, J. Hou, *J. Mater. Chem. A*, 1, 6614, 2013.
[12] J. Liu, X. Li, S. Zhang, X. Ren, J. Cheng, L. Zhu, D. Zhang, L. Huo, J. Hou, W.C. H. Choy, *Adv. Mat. Interface*, DOI:10.1002/admi.201500324.
[13] H. Lu, D. Zhang, J. Cheng, J. Liu, J. Mao, W. C. H. Choy, Adv Function. Mat., 25, 4211, 2015; H. Lu, D. Zhang, X. Ren, J. Liu, W. C. H. Choy, *ACS Nano*, 8, 10980, 2014.
[14] H. Lu, X. Ren, W. E. I. Sha, J. Chen, Z. Kang, H. Zhang, H.P. Ho, W. C. H. Choy, *Scientific Reports*, DOI: 10.1038/srep07876.
[15] F.X. Xie, D. Zhang, H. Su, X. Ren, K.S. Wong, M. Grätzel, W.C.H. Choy, *ACS Nano*, 9, 639, 2015.
[16] H. Zhang, J. Mao, H. He, D. Zhang, H.L. Zhu, F. Xie, K.S. Wong, M. Grätzel, W.C. H. Choy, *Adv. Energy Mat.*, DOI:10.1002/aenm.201501354.
[17] H. Zhang, J. Cheng, F. Lin, H. He, J. Mao, K.S. Wong, A.K.Y. Jen*, W.C.H. Choy*, *ACS Nano*, DOI: 10.1021/acsnano.5b07043.