Photoelectrochemical Water Splitting with $SrNbO_2N$ Photoanode Prepared by a Novel Roll-press Method

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Hydrogen produced via a photocatalytic and a photoelectrochemical route has been paid large attention to as a potential clean fuel. $SrNbO_2N$ is an attractive materials due to its long absorption edge of 690 nm which covers a wide range of visible light region[1]. In this study, a novel electrode preparation method, a roll-press method, was applied to $SrNbO_2N$ photoanodes. The effects of preparation conditions and post treatments were investigated.

$SrNbO_2N$ particles were synthesized by nitridation of $Sr_2Nb_2O_7$ oxide precursors under an NH_3 flow[2]. Obtained particles were drop-casted on a Nb substrate followed by roll-pressing as shown in Fig. 1 (Left). After pressing, pressed films were post-annealed under a N_2 flow at different temperature for 30 min. Photoelectrochemical properties were investigated in a typical three-electrode configuration.

After roll-pressing, particles were crushed and grain boundaries became unclear as shown in Fig. 1 (Right). Figure 2 shows current-potential curves of $SrNbO_2N$/Nb prepared by a roll-press method modified by CoPi as a cocatalyst[3]. Without post heating under N_2 flow, only several micro ampere of photocurrent was observed. According to increasing the annealing temperature, clear photocurrents appeared and photocurrent over 0.5 mA/cm^2 at 1.2 V_{RHE} was observed when heated at 873 K. It is more likely that annealing reduced the electrical resistance between particles and substrates. On the other hand, annealing at higher temperature reduced photocurrent probably due to the degradation of $SrNbO_2N$ particles at a high temperature.

As a brief summary, $SrNbO_2N$/Nb exhibited clear photoanodic current, indicating that the roll-press method is a promising way for electrode preparation. In the presentation, effects of other pre- and post-treatment on $SrNbO_2N$/Nb will be discussed.

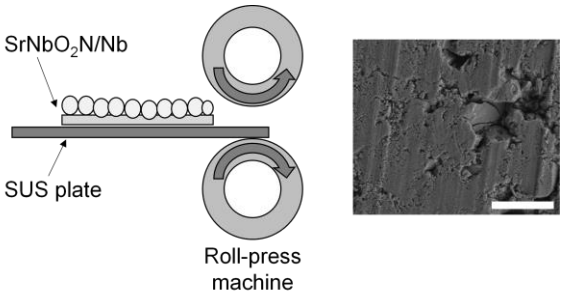

Fig.1 (Left) Schematic of a roll-press method. (Right) Top-view SEM image of $SrNbO_2N$/Nb electrode. Scale bar indicates 5 μm.

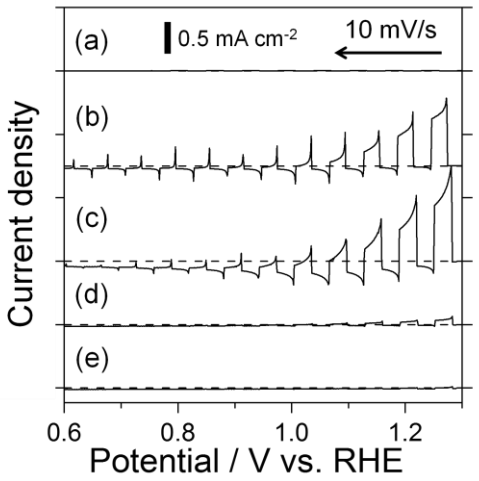

Fig. 2 Current-potential curves of $SrNbO_2N$/Nb photoelectrodes prepared by a roll-press method (a) w/o post-heating and (b)-(e) with different post heating temperatures. (b) 773 K, (c) 873 K, (d) 973 and (e) 1073 K. AM 1.5G, 1 M KBi solution (pH 10).

REFERENCES

[1] H. Urabe, T. Hisatomi, T. Minegishi, J. Kubota, and K. Domen, Faraday Discuss., 176 (2014) 213–223.
[2] M. Kodera, H. Urabe, M. Katayama, T. Hisatomi, T. Minegishi, and K. Domen, J. Mater. Chem. A, 4 (2016) 7658–7664.
[3] M. W. Kanan and D. G. Nocera, Science, 321 (2008) 1072–1075.