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HiPIMS deposition of Ta-O-N coatings with modified surface by Cu nanoclusters for water splitting application

Jiri Capek, Sarka Batkova, Jiri Houska

University of West Bohemia, Plzen, Czech Republic

jcapek@kfy.zcu.cz

As reported in [1], Ta-O-N material can provide appropriate properties (i.e., band gap width and alignment) for splitting of water into H_2 and O_2 under visible light irradiation (without any external voltage). This could bring a great possibility to convert the solar light into a useful chemical energy. However, it is still impossible to prepare the Ta-O-N electrodes by conventional (chemical) methods at the temperatures less than 500°C without post-annealing. Moreover, the efficiency of this material for water splitting is limited due to fast recombination rate of photogenerated electrons and holes.
Recently, we have demonstrated in our laboratory [2] that high-power impulse magnetron sputtering is a suitable technique for low-temperature (less than 250 °C) and high-rate (higher than 150 nm/min) deposition of Ta-O-N coatings with tunable elemental composition and optical band gap width. In this work, we focus on a further optimization of deposition conditions (e.g., average pulse target power density, working gas pressure, substrate bias and temperature) in order to reach proper crystal and electronic structures of Ta-O-N coatings with respect to the water splitting application. Moreover, we propose to modify the surface of the coatings by Cu nanoclusters in order to enhance the efficiency of water splitting due to a reduced recombination rate of electrons and holes. For this purpose, we have designed a unique dual magnetron-based system combining the reactive high power impulse magnetron sputtering with a source of metallic nanoclusters. The results of our experiments including the coating properties investigated using atomic force microscopy, spectroscopic ellipsometry and high-resolution SEM and preliminary data on photocatalytic activity will be presented in detail.
[1] R. Abe, J. Photochem. Photobiol. C Photochem. Rev. 11 (2010) 179.
[2] J. Rezek et al., Thin Solid Films. 566 (2014) 70.

Keywords
TaON
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