Sol-gel derived $BiVO_4$ coatings for use in PECs

Fernanda GARCIA[1], Audrey POTDEVIN[1], Thomas VOURC'H[2], Jérémi DAUCHER[2], Fabrice GROS[2], Jean-François CORNET[2], Damien BOYER[1]

[1] Université Clermont Auvergne, Clermont Auvergne INP, CNRS, Institut de Chimie de Clermont-Ferrand, F-63000 Clermont–Ferrand, France.
[2] Université Clermont Auvergne, Clermont Auvergne INP, CNRS, Institut Pascal, F-63000 Clermont–Ferrand, France.

The accelerated increase in population and industrialization has caused energy demand to become one of the biggest problems worldwide due to the high dependence on fossil fuels for energy generation. Consequently, scientific research has focused on the use of sustainable renewable energy sources to produce green fuels. The only source of energy capable of meeting the considerable needs of humanity in the 21st century is solar energy. The simplest, best known and today industrially mature solar process consists in powering an electrolyser with photovoltaic electricity to produce hydrogen by photolysis of water. Hydrogen is in fact indisputably the first solar fuel that humanity must be able to efficiently produce. Artificial photosynthesis or photocatalytic water splitting (PWS) makes it possible to split the water molecule in a single step and with a single technology. This is definitely a promising route for the production of hydrogen. The development of high efficiency PWS processes for industrial solar hydrogen production requires efficient Photo-Electrochemical Cells (PECs)[1]. The first technological barrier limiting the effectiveness of the process is the photoanode. To overcome this barrier, achieving nanostructured materials of controlled morphology and tuning their electronic band structure is necessary. It can be reached by playing respectively on their synthesis process and their chemical composition or crystalline structure. Among the possible materials, $BiVO_4$ stands out for its chemical stability, lead-free composition, piezoelectric nature, and optical performance (Eg around 2.4eV)[2-3].

In this work, the elaboration of $BiVO_4$ coatings was carried out using different kinds of bismuth precursor and vanadium alkoxide through an original sol-gel method followed by dip-coating on FTO substrates. The coatings were characterized by DRX, FT-IR, Raman spectroscopy, SEM/AFM, and UV-vis spectroscopy. Homogeneous and crystallized $BiVO_4$ coatings were obtained (see Figure 1(a)) and they are characterized by a band gap energy interesting for the foreseen application (see Figure 1(b)). Finally, H_2 production using the elaborated coatings in PECs was studied. The results obtained will be discussed depending on the bismuth precursor used and the deposition and heat treatment conditions.

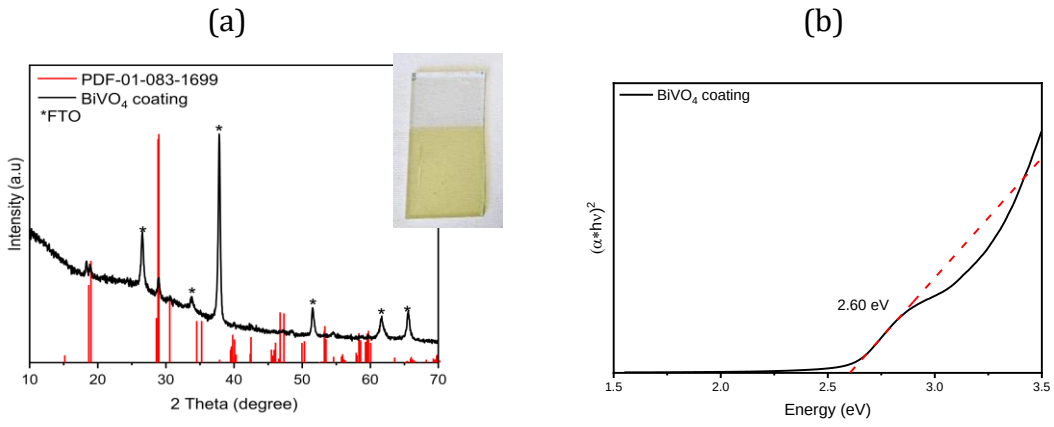

Figure 1 (a) XRD pattern of sol-gel derived $BiVO_4$ coating on FTO substrate – photograph of the coating (insert) (b) Tauc plot for the extraction of the optical band gap of the $BiVO_4$ coating.

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Mots clés : sol-gel synthesis, bismuth orthovanadates, water-splitting.

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