**Tailored liquid-phase chemistry to achieve low-temperature synthesis of BiVO4 for photoelectrochemical water splitting**

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In order to reduce global dependence on fossil resources, utilization of renewable energy sources is key. Electrification is accepted as an efficient path forward, but issues arise while matching supply and demand. These issues can be addressed by directly coupling energy harvesting to storage of energy, for example by using hydrogen as a means to store energy. To this purpose, photo water splitting is investigated over the last decades to link energy harvesting to energy storage, directly. Amongst other options, photoelectrochemical (PEC) hydrogen production is considered because of its potentially high energy efficiency due to a high level of (material) integration. Within this field, BiVO4 (BVO) is known to be a material with a good balance between durability, bandgap, absorption and bias requirements; all characteristics which are vital for versatile PEC electrodes[[[1]](#footnote-1)]. The high level of integration – often named as the hallmark of PEC technology – is limited by material synthesis and preparation methods[[[2]](#footnote-2)], which may require high temperatures of up to 600°C to yield functional BVO. These temperatures are destructive for typical TCO materials used, e.g. ITO or FTO. In addition, scalability of the material preparation process is vital to increase impact of the BVO and PEC technology in general.

In this study, we opted to lower the synthesis temperature of BVO using wet-chemical methods while using solvents and processes which allow cost-effective and scalable production in the near future. Wet-chemical processing of BVO was established by using aqueous and non-aqueous formulations. A broad range of solvents was considered, combining liquid phase and metal-ion compatible ligands and / or stabilizers that could lead to soluble complexes. Suitable combinations were found and studied by using thermogravimetric analysis (TGA) and powder X-ray diffraction (XRD). Various deposition methods were employed for layer formation from small to large scale, ranging from spincoating and dipcoating to spray deposition, yielding functional devices consisting of several stacked materials. These materials were further studied with thin film XRD, optical spectroscopy (UV-VIS) and linear sweep voltammetry (LSV) using a solar simulator (AM 1.5). The result obtained in this study indicate that tetragonal BVO crystallization onset occurs at 300°C, where Bi2O3 may form a secondary phase. Upon increasing the temperature to 400°C, the purity of BVO increases. To increase the photocurrent, an electron transfer layer (WO3) and BVO doping with Mo(VI) was applied. The photocurrent increased to 1.45 mA/cm2. This outcome opens possibilities to use TCO’s with limited temperature stability and enhance BVO quality by limiting negative solid state diffusion effects such as sodium migration. In addition, larger scale application has been shown as well, potentially increasing the impact of this technology in the near future.

1. Yi et al., ChemElectroChem 2025, 12 (4) e202400600 [↑](#footnote-ref-1)
2. Vilanova et al., Chem. Soc. Rev. 2024, 53, 2388 - 2434 [↑](#footnote-ref-2)