Abstract: Mimicking photosynthesis and producing solar fuels is an appealing way to store the huge amount of renewal energy from the sun in a durable and sustainable way. Hydrogen producing through water splitting has been set as a primary target for artificial photosynthesis which requires the development of efficient and stable catalytic systems, only based on earth abundant elements, for the reduction of protons from water to molecular hydrogen. We will report on our contribution to the development of various series of catalysts for $\text{H}_2$ evolution, including the reinvestigation of amorphous molybdenum sulfide and to the establishment of methodologies towards the rational benchmarking of their catalytic activity. Besides, we will also describe our effort towards the combination of such catalysts with various photoactive motifs for the preparation of photoelectrode materials that can be implemented into photoelectrochemical (PEC) cells for water splitting.