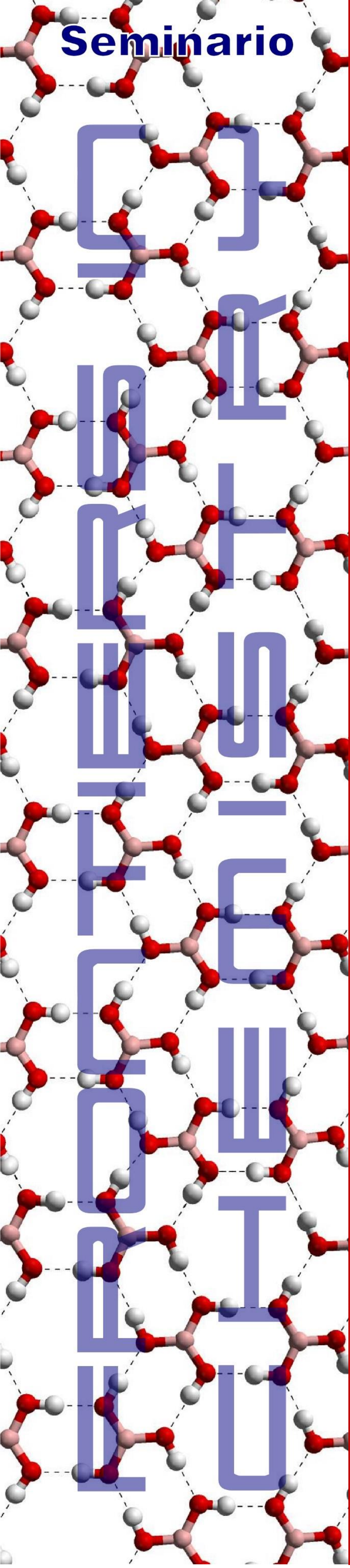

Università degli Studi di Padova
Dipartimento di Scienze Chimiche

Ciclo di Seminari 'Frontiers in Chemistry'

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Photocatalytic water splitting for solar hydrogen production on a large scale

Giovedì 7 Luglio 2022, ore 10.00
Aula A, Dipartimento di Scienze Chimiche, Via Marzolo 1 - Padova

Sunlight-driven water splitting is studied actively for production of renewable solar hydrogen as a storable and transportable energy carrier. Both the efficiency and the scalability of water-splitting systems are essential factors for practical utilization of renewable solar hydrogen. Particulate photocatalyst systems do not involve any secure electric circuit and can be spread over wide areas by inexpensive processes potentially. Therefore, it is highly impactful to develop particulate photocatalysts and their reaction systems that efficiently split water[1-3].

The author's group has studied various oxides, (oxy)nitrides, and (oxy)chalcogenides. The water splitting activity of a $SrTiO_3$ photocatalyst can be boosted by two orders of magnitude by doping Al, and recently the quantum effciency has reached to almost unity [4]. Through tuning of the preparation and modification methods, the apparent quantum yield of photocatalytic water splitting has reached 95% at near UV region. This quantum efficiency is the highest yet reported, and confirms that a particulate photocatalyst can drive the greatly uphill overall water splitting reaction as efficiently as photon-to-chemical conversion processes in photosynthesis.

The author's group has been developing panel reactors in view of large-scale application. A prototype panel reactor containing Al-doped $SrTiO_3$ photocatalyst sheets splits water and releases product hydrogen and oxygen gas bubbles at a rate corresponding to a solar-to-hydrogen energy conversion efficiency (STH) of 10% under intense UV illumination. We have constructed a prototype solar hydrogen production system with light receiving area of 100 m^2 and H_2 separation system from the mixture of H_2 and O_2 (2:1) containing saturated water vapour [5].

It is essential to develop photocatalysts active under visible light irradiation for practical solar energy harvesting. Ta_3N_5 and $Y_2Ti_2O_5S_2$ photocatalysts show activity in overall water splitting via one-step excitation under visible light irradiation [6,7]. Particulate photocatalyst sheets split water into hydrogen and oxygen via two-step excitation, referred to as Z-scheme, efficiently regardless of the size. In particular, a photocatalyst sheet consisting of La- and Rh-codoped $SrTiO_3$ and Mo-doped $BiVO_4$ exhibits STH exceeding 1.0% [8,9]. Some other (oxy)chalcogenides and (oxy)nitrides with longer absorption edge wavelengths are also applicable to photocatalyst sheets.

In my lecture, the latest progress in photocatalytic materials and reactors and concepts toward large-scale operation will be presented.

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[7] Q. Wang *et al. Nat. Mater.* **2019**, 18, 827.
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