Contribution ID : **77** Type : **Poster**

High crystallinity nitrogen doping of ALaTiO4 and A2La2Ti3O10 (A = Na¬+, K+) photocatalysts

Thursday, 25 November 2021 18:59 (1)

Global warming is a current hot topic due to its potential for irreversible environmental damage. Ambitions were made within the Paris agreement to limit the temperature rise to be below 1.5 °C pre-industrial level. Therefore, alternative fuel sources are needed to replace fossil fuel, with hydrogen gas is one popular choice due to its high energy density per unit weight, and technologies utilising hydrogen already developed. Hydrogen can be generated renewably by sunlight driven, photocatalytic water-splitting. Metal oxides, including those with a Ruddlesden-Popper type structures are being studied as potential photocatalysts. KLaTiO4 is a n=1 Ruddlesden-Popper type layered perovskite. KLaTiO4 can be used as a Hydrogen Evolution Catalyst (HEC), producing 9.540 µmol of H2 gas per hour from 20 mg of catalyst, when using methanol as sacrificial electron donor and platinum co-catalyst. The main issue of KLaTiO4 is its high bandgap (4.09 eV) meant it is incapable of absorbing visible light.
The two main factors important for the synthesis of ALaTiO4 and A2La2Ti3O10 (A = Na¬+, K+) was discussed: volatility of alkaline metal ions at elevated temperatures and sintering temperature. Multiple samples of NaLaTiO4 or Na2La2Ti3O10 were made using traditional solid-state synthesis methods at temperature between 750 ℃ to 950 ℃. Bandgap was tuned by doping nitrogen into the structure of ALaTiO4 during the synthesis process, as opposed to replacing oxygen atoms with nitrogen by post treatment of ALaTiO4. This was achieved by replacing a portion of TiO2 reagent used for TiN, and the sample was synthesised as normal. The resultant ALaTiO4-xNx¬ sample retained good crystallinity and have reduced bandgap, but at a cost of reduction in hydrogen evolution rate.

Level of Expertise

Student

Presenter Gender

Man

Pronouns

Which facility did you use for your research

Australian Synchrotron

Students Only - Are you interested in AINSE student funding

Do you wish to take part in the Student Poster Slam

Condition of submission

Yes

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Session Classification : Poster Session

Track Classification : Advanced Materials