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Light-Initiated Degradation of PFAS Using High Redox Potential Photocatalysts

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ABSTRACT

There is an imminent need to develop degradation pathways for Per- or Polyfluoroalkyl Substances (PFAS) to relieve current global contamination. PFAS are toxic, ubiquitous and consist of the C–F bond, which is recalcitrant to common degradation processes. Photocatalysis is a promising alternative for PFAS degradation provided the photocatalyst has sufficient reduction or oxidation (redox) potential. $ATaO_3$ (A = Li, Na, K, Ag) photocatalysts have high redox potential due to the empty Ta 5d orbitals and are therefore a potential option to drive the reduction/oxidation of the C–F bond. $ATaO_3$ (A = Li, Na, K) band gaps range from 3.6 – 4.7 eV and their activity can be further improved by La-doping at the A-site of the perovskite lattice.[1,2] This study reports, for the first time, the photocatalytic degradation of PFAS using La-doped $ATaO_3$ (A = Li, Na, K) photocatalysts with varying La doping percentage.

$ATaO_3$ (A = Li, Na, K) were first synthesised via a solid-state high temperature synthesis with varying La mol % doping, following previous studies.[1] The band gap of the photocatalysts were determined from UV-Vis DRS, the crystal structure was determined by powder XRD, and the morphology and particle size were analysed by SEM. Degradation reactions with perfluorooctanoic acid (PFOA) were conducted in batch-style and circulating flow systems under UV-LED irradiation. PFOA conversion and by-product evolution were monitored by Liquid Chromatography-High Resolution Mass Spectrometry (LC-HRMS) and fluoride was quantified using an ion selective electrode. Our results highlight the effect of La doping mol % and the A site element on photocatalytic PFAS conversion efficiency, and selectivity toward producing fluoride.

[1] Kato H, Asakura K and Kudo A. *J. Am. Chem. Soc*., **2003,** *125*, 3082-3089.

[2] Sudrajat H, Kitta M, Ito R, Nagai S, Yoshida T, Katoh R, Ohtani B, Ichukuni N, Onishi H. *J. Phys. Chem. C.*, **2020,** *124*, 15285-15294.

KEY WORDS

PFAS, Photocatalysis, PFOA, Degradation, Fluoride

BIOGRAPHY

Rachael Matthews is a current PhD candidate at The University of Adelaide working under the supervision of Dr. Cameron Shearer. Rachael obtained a Bachelor of Science in 2022, followed by a First Class Honours in 2023, also at The University of Adelaide. She is a current member of the Photo-Cat Group, who research innovative and sustainable solutions to various environmental issues. Her research specifically focuses on synthesising new inorganic materials for the photocatalytic destruction of per- or polyfluoroalkyl substances (PFAS).

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