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Photocatalytic Methanol Reforming over Cs_2RuX_6 (X = Cl, Br) Double Perovskites: H_2 Evolution and Carbon-Containing Gas Formation

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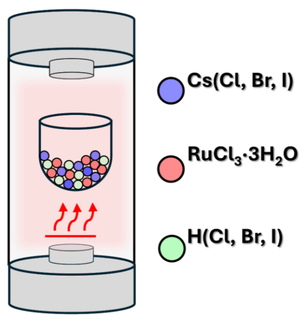
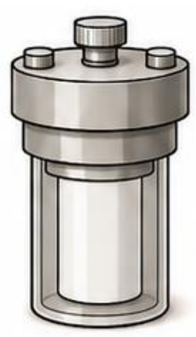
INTRODUCTION & AIM

Hydrogen can decarbonise hard-to-electrify sectors, yet it is still commonly produced through energy-intensive, fossil-based routes today. Methanol offers a practical liquid hydrogen carrier, but releasing H_2 cleanly while controlling carbon-containing by-products remains a key challenge in selectivity—photocatalytic methanol reforming addresses this problem by using light to drive reactions under mild conditions. Here, Cs_2RuX_6 (X = Cl, Br) vacancy-ordered double perovskites are explored as tunable, visible-light-absorbing photocatalysts for H_2 evolution and carbon product mapping under ambient conditions. [1-4]

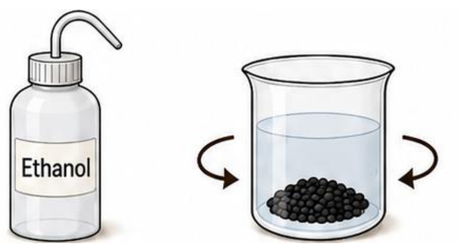
METHOD

1 Hydrothermal synthesis of Cs_2RuX_6 perovskites

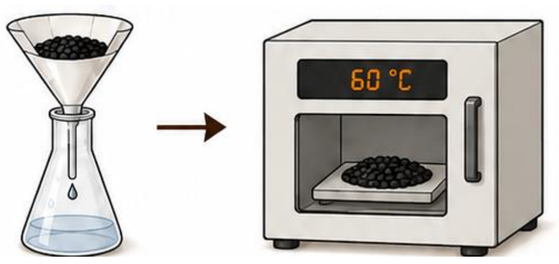




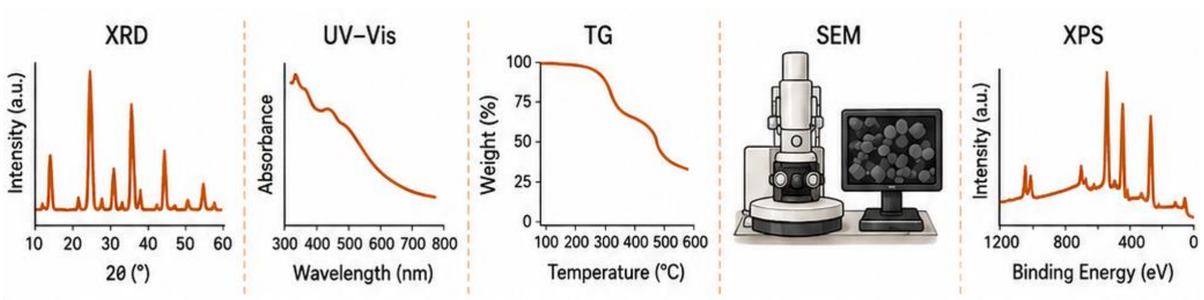
2 Washing with ethanol



3 Filtered and dried at 60 ºC

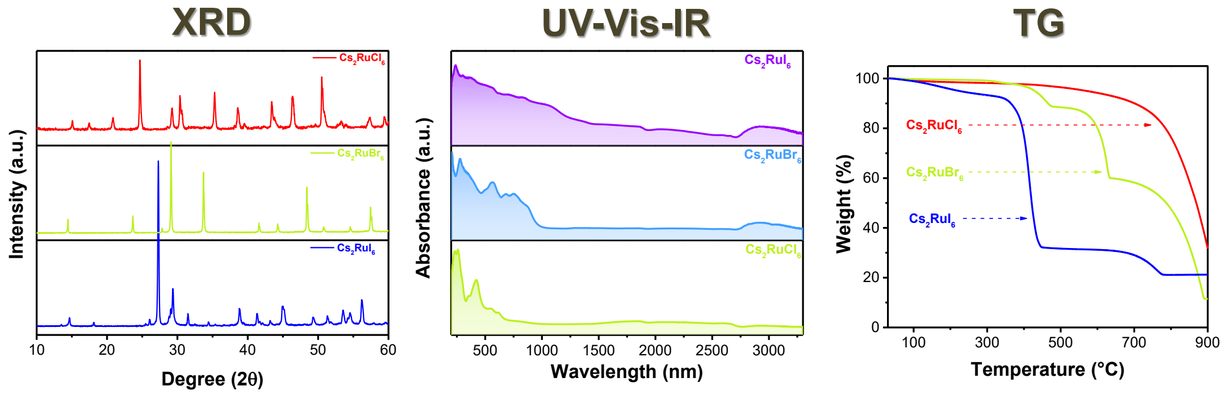


4 Characterization



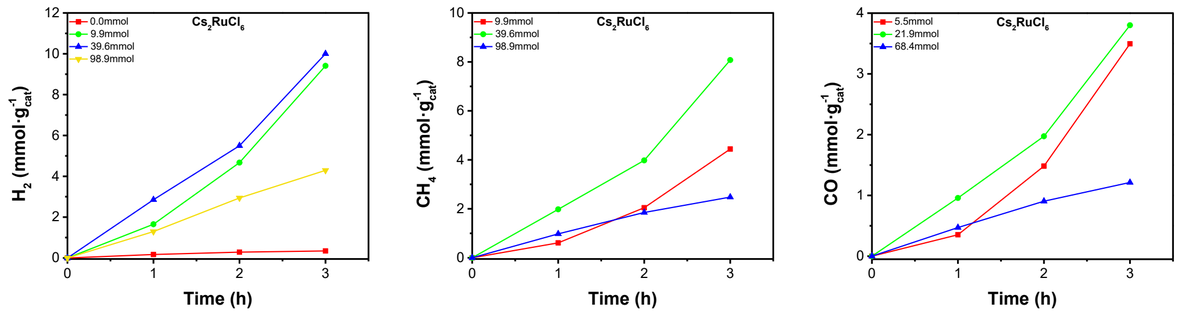
RESULTS & DISCUSSION

1 Characterization of perovskites

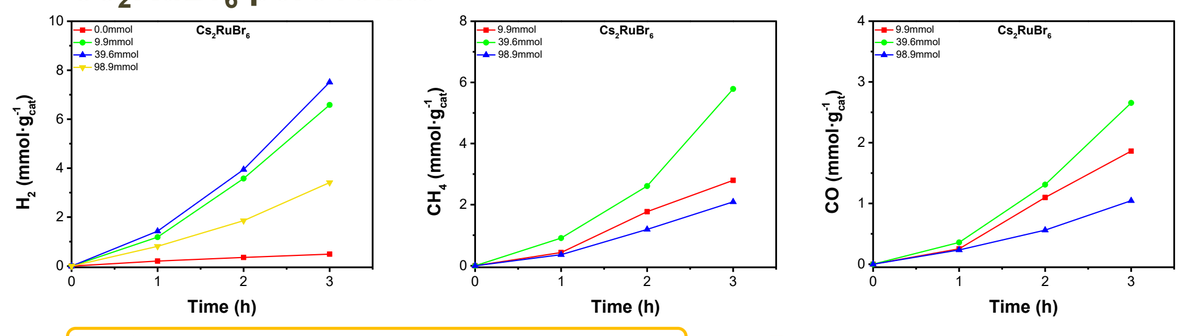


2 MMR performance summary

Cs_2RuCl_6 perovskite



Cs_2RuBr_6 perovskite



- ✓ 39.6 mmol MeOH gives the highest activity.
- ✓ Cs_2RuCl_6 outperforms Cs_2RuBr_6.
- ✓ CH_4 is the dominant carbon-containing product.

Reaction Conditions: 10 mg catalyst, 25 ºC, 1.0 bar Ar, 130 mW·cm^{-2}, **3h**.

CONCLUSION

-Cs_2RuX_6 (X = Cl, Br) double perovskites were successfully prepared by hydrothermal synthesis and structurally characterized.

-Both materials enabled photocatalytic methanol reforming under mild conditions, producing H_2 and carbon-containing gaseous products.

-Halide composition influenced product distribution, highlighting Cs_2RuX_6 as a tunable platform for selective solar fuel production.

FUTURE WORK / REFERENCES

[1] Mego, K, et al. Sunlight-Driven Green Synthesis of Platinum Nanoparticles from Double-Vacancy Halide Perovskite Precursors for Methanol Reforming. *Chem. Eur. J*. **2026,** e03192.
[2] Thirumalesh, B. S.; Asapu, R. State of the Art of Methanol Reforming for Hydrogen Generation. *ChemBioEng Rev.* **2024**, *11* (3), 543–554.
[3] Liu, X., et al. Unlocking Ethane Production in Photocatalytic Methanol Reforming Based on a Novel Carbon–Carbon Coupling Mechanism. *Chem. Eng. Sci.* **2024**, *296*, 120262.
[4] Chang, L., et al. A Review of Methanol Photoreforming: Elucidating the Mechanisms, Photocatalysts and Recent Advancement Strategies. *Mater. Today Chem.* **2023**, *27*, 101334.