Doped-perovskites for the solar-powered photocatalytic valorisation of CO_2

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Significance and Relevance

The design of photo-active materials sensitive to the full solar spectrum would be highly desirable to enable the scaling up of CO_2 valorization through photocatalytic and solar technologies. Doped Ba and Ca titanates were successfully employed for the first time in CO_2 photoreduction using solar light.

Preferred and 2nd choice for the topic: CO2 utilization and recycling; Photocatalysis
Preferred presentation: Oral/Short Oral

Introduction and Motivations

Carbon dioxide is an abundant greenhouse amongst the main contributor to the global warming effect. Different strategies have been proposed to reduce CO_2 concentration in the atmosphere, including the conversion into high value-added products like fuels and chemicals[1].

Photocatalysis, intended in this case as CO_2 photoreduction in presence of water vapor, is an alternative catalytic approach, which exploits solar energy as an abundant, unlimited, renewable energy source to enable carbon dioxide conversion into different solar fuels[2], without requiring additional energy input to make the reaction take place. Perovskites such as barium titanate ($BaTiO_3$) and calcium titanate ($CaTiO_3$) are promising photocatalytic materials which show good photostability, corrosion resistance in aqueous solutions and band gap necessary to obtain all the products of carbon dioxide reduction. However, they absorb UV radiation, which constitutes only 4% of the solar spectrum.

Materials and Methods

$BaTiO_3$ and $CaTiO_3$ perovskites were prepared via hydrothermal synthesis and doped with non-metal dopants. The materials were characterized through FT-IR, DRS, SEM-EDX, TEM, N_2 physisorption, and XRD techniques and then tested for CO_2 photoreduction in a gas phase batch reactor.

Results and Discussion

Bare barium and calcium titanates were not active under solar irradiation. However doped perovskites showed good photoactivity under when irradiated with solar light. Compared to the bare perovskites, doping the materials with heteroatoms, likely led to a narrowing of the band gap, suggesting their acquired activity in the visible region of the spectra. Figure 1 shows the increased absiption ability of two differently doped perovskites compared to the bare materials, BaT and CaT. Doped $CaTiO_3$ showed the best photocatalytic activity reaching a TON up to 1.8 μmol/g_{cat} relative to methane production.

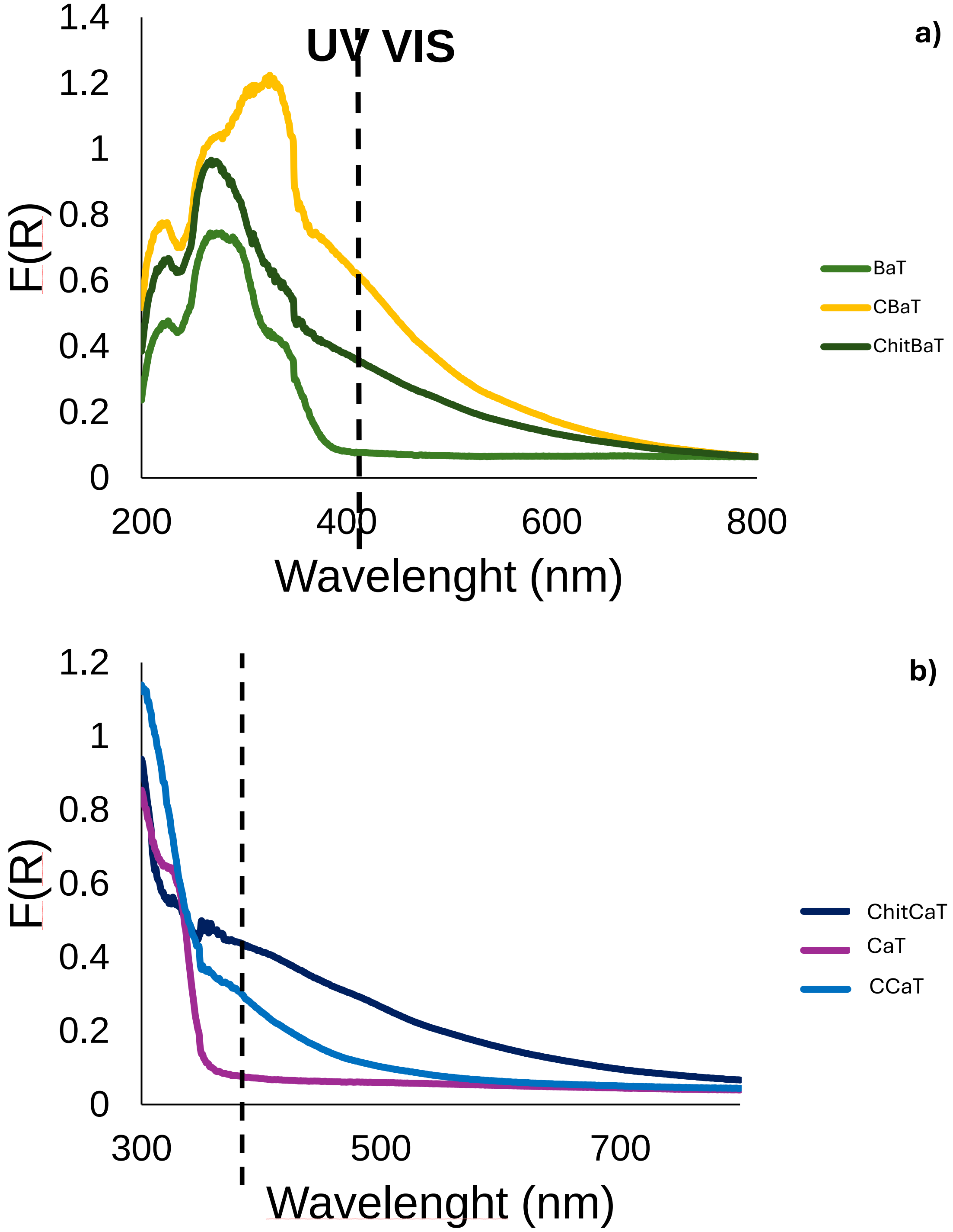

Figure 1 Diffuse reflectance spectra of a) Ba-based and b) Ca-based doped and non-doped materials.

References

1. L. Al-Ghussain, *Environ. Prog. Sustain. Energy*. **2019**, 38, 13-21
2. L. Sun, Y. Wang, N. Guan, and L. Li, *Energy Technol.* **2020**, 8, 1900826

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