The effects of silane layers on the degradation pathways of ZnO of hybrid inorganic-organic perovskites

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Abstract

Despite the significant increase in the efficiency of perovskite-based solar cells, their instability remains a problem. Using zinc oxide (ZnO) as an electron transport layer (ETL) in a solar cell easily degrades the perovskite layer because of ZnO’s basic nature. To try to prevent or slow down this degradation process, a silane layer was placed between the ZnO and the perovskite. Once glass substrates were spin-coated with diluted ZnO, they were immersed in diluted (3-aminopropyl)trimethoxysilane or (3-aminopropyl)trimethoxysilane and spin-coated with a perovskite solution and toluene. It was observed that the substrates that were immersed in silane layer degraded slower and with less intensity than the substrates that were not immersed. Based on these findings, it is imperative to conduct more research about the interaction between the silane and the compounds in the perovskite to determine ways to make photovoltaic cells more stable and functional.

Introduction

- Huge manufacturing energy requirement of silicon-based solar cells led to research in perovskite-based photovoltaic cells
- Structure of a Perovskite Compound1
- Structure of a Perovskite Photovoltaic Cell
- Zinc oxide (ZnO) chosen as an alternative ETL because of lower manufacturing energy cost than titanium dioxide (TiO₂), but ZnO degrades the perovskite because of ZnO’s basic nature3
- This research aimed to determine whether adding a silane layer between the ETL and the perovskite would prevent degradation

Methods

1. Synthesis of ZnO
2. Synthesis of perovskite
3. Fabrication of ETL and perovskite layer

Results and Conclusion

- No perovskite degraded after annealing at 100°C for 10 minutes
- Silane effective in increasing stability of the perovskite
  - May be due to silane bonding with ZnO, preventing ZnO from deprotonating perovskite
  - Trend of results in substrates without silane and Sn contradicted previous research
  - Previous research claimed increase in stability when concentration of Cs was increased2
  - May be due to experimental errors or unconfirmed mechanisms between the compounds
- Perovskites with Sn lasted longer before methylammonium degraded, but it could not be identified whether the silane or the Sn improved stability

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References