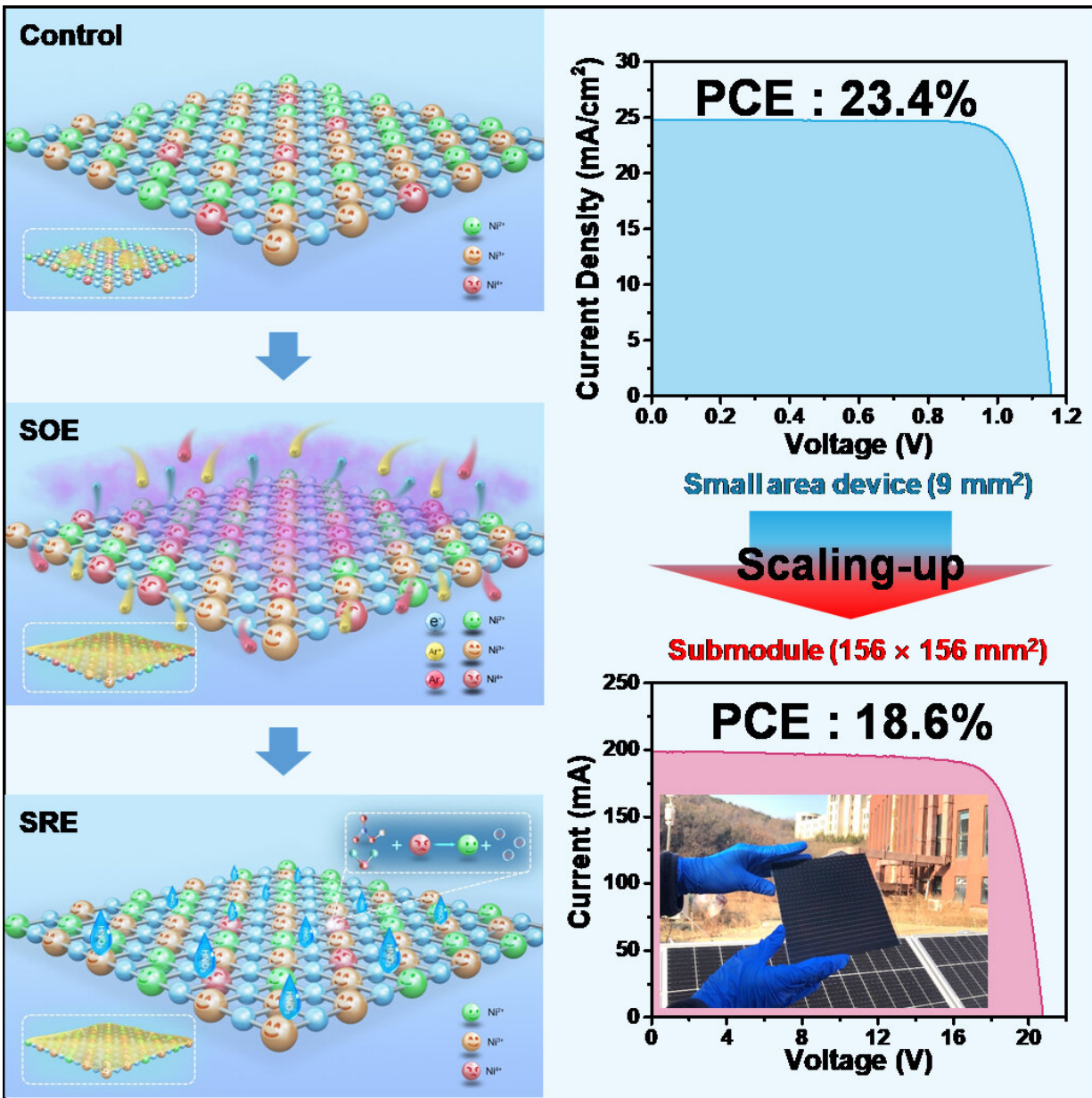


# Scientists fabricate high-performance, large-area perovskite submodules for solar cells

July 28 2022, by LI Yuan



Schematic illustration of SRE for NiO<sub>x</sub> films and photovoltaic parameters of SRE-perovskite devices. Credit: DU Minyong

Perovskite solar cells (PSCs) are promising solar technologies. Although low-cost wet processing has shown advantages in small-area PSC fabrication, the preparation of uniform charge transport layers with thickness of several nanometers from solution for meter-sized large area products is still challenging.

Recently, a research group led by Prof. Liu Shengzhong from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) has developed a facile surface redox engineering (SRE) strategy for [vacuum](#)-deposited NiO<sub>x</sub> to match the slot-die-coated [perovskite](#), and fabricated high-performance large-area perovskite submodules.

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Inverted PSCs are potentially more valuable than their normal counterparts because the former have easily mitigated hysteresis behavior and long-term durability. NiO<sub>x</sub> has been demonstrated as the hole transport materials for inverted PSCs. But for most vacuum-processed NiO<sub>x</sub> films, the relatively [hydrophobic surface](#) attenuates the adhesion of perovskite ink, making it challenging to deposit large-area perovskite films.

Moreover, the surface chemistry of NiO<sub>x</sub> is rather complex as a large number of high-oxidative-state Ni species and chemically reactive hydroxyls can decompose perovskites, leading to an interface energy barrier and noncapacitive hysteresis.

The SRE strategy not only eliminates the local de-wetting problem of perovskite ink, thus achieving uniform polycrystalline perovskite films at the decimeter level, but also imparts enhanced performance in [electronic properties](#), stability, mechanical adhesion at the buried interface via modulating the  $\text{NiO}_x$  surface features.

In this study, the researchers achieved high-performance PSCs with stability of thousands of hours under various stressed conditions and outstanding photovoltaic performance. The power conversion efficiencies of PSCs were 23.4% and 21.3% for rigid and flexible devices, respectively.

Furthermore, due to the scalability of SRE strategy to large-area configurations, they assembled perovskite submodules of area  $156 \times 156 \text{ mm}^2$  with a remarkable efficiency of 18.6% along with negligible hysteresis and good [stability](#).

"The SRE strategy provides a proof of concept for combining vacuum-fabricated charge transport layers with wet-processed perovskites and facilitates the stacking engineering of large-scale, uniform thin films for the development of efficient and stable perovskite modules," said Prof. Liu.

**More information:** Minyong Du et al, Surface redox engineering of vacuum-deposited  $\text{NiO}_x$  for top-performance perovskite solar cells and modules, *Joule* (2022). [DOI: 10.1016/j.joule.2022.06.026](https://doi.org/10.1016/j.joule.2022.06.026)

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