Transparent graphene electrodes for perovskite/silicon tandem solar cells

Marc A. Gluba, Felix Lang, Norbert H. Nickel

Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Institut für Silizium Photovoltaik,
Kekuléstr. 5, 12489 Berlin, Germany
marc.gluba@helmholtz-berlin.de

Abstract

The combination of functionality and processability renders graphene the clear choice to replace conventional electrode materials for top solar cells in tandem devices. Recently, hybrid perovskites, such as methylammonium lead halides were established as novel high bandgap absorber materials for photovoltaic energy conversion[1]. The top solar cell of a tandem design requires contacts which are optimized for optical transparency and electrical conductivity. At the same time, the delicate perovskite absorber material impedes the sputter deposition of conventional transparent conductive oxides. In contrast, large-area graphene shows outstanding optoelectronic properties and offers a gentle transfer process.

In this paper, we demonstrate the implementation of a large-area graphene electrode into a perovskite solar cell design[2]. For this purpose graphene was grown by catalytic decomposition of methane on a hot copper foil and subsequently transferred onto the perovskite absorber. Using a novel water-free transfer process the graphene contact approaches identical charge collection efficiencies compared to evaporated gold electrodes. Moreover, the electrical performance of solar cells with a graphene-based contact reached those of conventional reference devices. The use of a highly transparent graphene contact renders the perovskite solar cell semi-transparent with an optical transmission of 64.3% below the perovskite band gap. We present the implementation of a semi-transparent perovskite top solar cell into a four terminal tandem device in combination with an amorphous/crystalline silicon bottom solar cell. Implications of the graphene electrode on the power conversion efficiency will be discussed.

References

[1] G. Hodes, Science **342** (2013) 317–318.
[2] F. Lang, M.A. Gluba, S. Albrecht, J. Rappich, L. Korte, B. Rech, and N.H. Nickel, J. Phys. Chem. Lett. **6** (2015) 2745–2750.

Figures