Rb-In-S: A promising post-deposition treatment for high efficiency $Cu(In,Ga)Se_2$-based solar cells

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After the discovery of the sodium beneficial effects on the photovoltaic performance, the alkali fluoride –based post-deposition treatment has further boosted the device performance [1-4]. Up until now, the $Cu(In,Ga)Se_2$ record cells were obtained using PDTs under selenium atmosphere. In this work, we change the chalcogen atmosphere of the PDT and we compare four different PDTs performed under elemental sulfur (S) evaporation.

The present study examines CsF(S), NaF/RbF(S), RbF(S) and In+RbF(S) PDTs and seeks to address how to perform the PDT process in order to increase the device performance. Moreover, our research calls into question the effect of the alkali element on the composition, the morphology and the radiative recombination phenomena at the absorber's surface.

Our photoluminescence (PL) results show that the RbF(S) and In+RbF(S) exhibit the higher PL intensity and thus the lower radiative recombination activity at the surface. The CIGSe/In+RbF(S)-based solar cells exhibit the higher photovoltaic performance (19.3%, without anti-reflecting coating) mainly due to its higher V_{oc} and FF values. The Raman and scanning electron microscopy indicate the formation of a thin and slightly Cu-poor layer at the absorber's surface only in the case of the CIGSe/In+RbF(S) sample. This observation could be the key factor that enhance the effectiveness of the Rb-related PDTs performed under elemental S evaporation.

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