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Abstract
Different types of dual-junction solar cells (perovskite/silicon and GaInP/(Al)GaAs) are used in an investigation of measurement uncertainty for electrical characterization of multi-junction solar cells. A method traceable to international reference standards is presented. The spectral mismatch factor matrix is introduced and used with a Monte-Carlo method including manifold correlated and uncorrelated uncertainties. In this way, a detailed analysis of the solar simulator's spectral irradiance and its influence on uncertainty becomes possible. The use of subcell-adapted and broadband reference solar cells is addressed regarding their impact on uncertainty. This allows for finding optimal conditions for calibration with lowest measurement uncertainty. The short-circuit current of a series connected multi-junction solar cell is affected by luminescence coupling and other effects. With an experimental method it is shown how the uncertainty of the device short-circuit current can be precisely determined. The spectrometric characterization method allows deriving uncertainties of all I–V parameters. In this way a complete evaluation of measurement uncertainty for the calibration of multi-junction solar cells at standard testing conditions is introduced. This article is an extension to our work presented at the 46th IEEE PVSC. Here, we have added a detailed analysis of the influence of different solar simulator spectral irradiance distributions on measurement uncertainty by evaluating a Monte Carlo simulation introducing correlation coefficients. In addition for the first time, it is shown how luminescent coupling influences the calibration of multi-junction solar cells and how the effect needs to be implemented into the uncertainty of measurement for the short-circuit current as well as efficiency.