ABSTRACT
In this paper, flexible silicon thin-film solar cells on polyimide are encapsulated by organic silicon and inorganic silicon oxide (SiOx) stacked layers. This encapsulation replaces conventional encapsulation, which involves ethylene-vinyl acetate (EVA). The effects of the number of stacked layers on encapsulation of silicon thin-film solar modules are investigated. Experimental results show that the six-pair stacked layer yields a water vapor transmission rate of as low as 10^{-6} g/m² day, satisfying the requirements of solar cell encapsulation. The measurements of internal stress confirm that a thin organic silicon layer greatly reduces the internal stresses over the whole device structure, preventing the cracking of SiOx and the consequent failure of the encapsulation. Solar modules that are encapsulated with a six-pair stacked layer not only exhibit a higher initial conversion efficiency than those encapsulated by EVA but also exhibit less performance degradation after being used outdoors for many hours. Bending test shows that after 5000 bendings, stacked layer encapsulation yields a device performance maintenance of 89.1%, while encapsulation in EVA maintains only 85.1% of device performance. These results suggest that silicon stacked layers have great potential for encapsulating flexible thin-film solar cells, and represent a favorable alternative to conventional EVA.

Keywords: Encapsulation, flexible solar cell, organic silicon, water vapor transmission rate (WVTR)