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A thermo-visco-elastic shear-lag model for the prediction of residual stresses in photovoltaic modules after lamination

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Abstract. The distribution of residual thermo-elastic stresses in encapsulated solar cells arising from lamination is relevant for the characterization of the long term performance of photovoltaic (PV) modules during service. Accurate modelling of the structural response of the laminate in the transient regime during cooling after lamination is a challenging task from the computational point of view. In this work we propose a semi-analytic model based on the beam theory and the shear-lag approach for the treatment of the polymeric encapsulant layers and accounting for their time and temperature dependency according to a rheological model derived from fractional calculus considerations. Spatially uniform and non-uniform temperature distributions are compared to accurately assess the amount of the residual compressive stresses raised in the Silicon cells after lamination. The use of more realistic non-uniform temperature distributions leads to lower residual compressive stresses in Silicon as compared to the uniform case.

Keywords: photovoltaics, residual stresses, laminates, shear-lag theory, thermo-visco-elasticity, polymeric encapsulant.

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