# Master thesis: Thermomechanical simulation of building-integrated photovoltaic modules with aluminum rear sides

To face the goal of a carbon-neutral society, a massive installation of renewable energies such as photovoltaics (PV) is required. In order to avoid the competition for land, especially with food production, there is the need to integrate PV in already used surfaces. Building-integrated PV (BIPV) has a huge potential on the one hand by the large areas available and on the other hand by the spatial proximity of power generation and consumption. Another advantage is the balanced power generation over the day due to the different orientations of building skins. For aesthetic reasons the PV modules should be integrated suitably into the buildings, so that the modules become part of the building structure and therefore new PV module technologies have to be developed. This is done at the Institute for Solar Energy Research Hamelin (ISFH) associated with the Leibniz Universität Hannover. They work on solar-active façade elements based on common materials as for example aluminum profiles (see Fig. 1). By using an aluminum substrate with a high thermal expansion coefficient instead of a glass substrate, additional thermomechanical stress is brought into the module. This mechanical stress makes the PV module with aluminum rear side degrade much faster in thermal cycling tests than standard PV modules with glass and polymer covers, as shown in Fig. 2.

*Figure 1: PV module on a structured aluminum facade element built at ISFH.*

In order to support the experimental results and to enable better understanding of the degradation mechanism of PV modules with aluminum rear sides, we offer a master thesis developing a finite element (FE) simulation model of such PV modules (cross section see Fig. 3) with the help of the simulation software Abaqus. Based on this model, thermomechanical stress and strain in the individual components of the PV module will be computed. Several parameter variations will be run in order to minimize thermomechanical stress, just as it is done experimentally at ISFH. Such variations include for example the size of the modules, the size of the solar cells in the module or the mechanical properties of the encapsulant surrounding the solar cells. The simulation results will be compared to the experimental results and interpreted such that qualitative and quantitative explanations for the observed module degradation under thermal cycling are found.

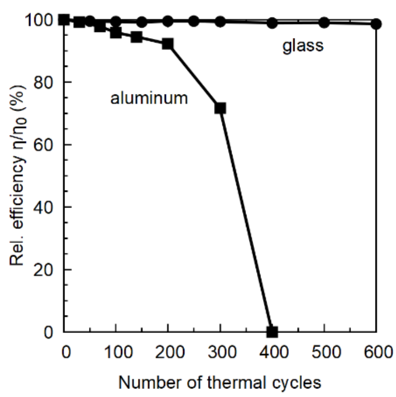


*Figure 2: Measured efficiency of PV modules with aluminum or glass cover during thermal cycling tests relative to the initial values. Thermal stress makes the module on aluminum degrade much faster.*

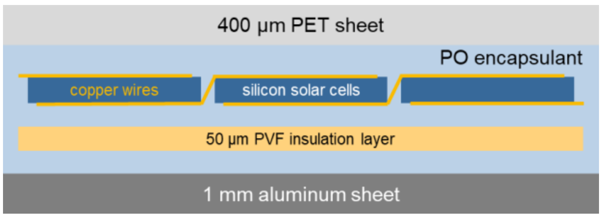


*Figure 3: Material stack of a PV module with aluminum rear cover. This is the structure, which shall be simulated in the Master thesis.*