Simulation of Thermo-Mechanical Strain in Extruded Polymeric Absorbers for Solar Thermal Collectors

E. Klimm[1], C. M. Yandiola[1], A. Piekarczyk[1], K.-A. Weiss[1]

[1]Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany

Abstract

1. Introduction

The solar thermal energy is, in comparison to fossil fuels, an environmentally friendly alternative for heating and hot water production. Recent research suggests that polymeric materials can be a cost-saving and environmentally friendly alternative to the common metals used in solar thermal collectors.

1.1 Structure of polymeric absorber

During the extrusion process of twin-wall sheet absorbers, a natural deformation of the profiles cross section occurs, caused by the shrinkage behavior of the polymer. Changes in the cross-sectional geometry may lead to an unfavorable distribution of the thermo-mechanical stresses in the absorber and influence in consequence the service life of the material.

1.2 Investigative Approach

In service, the absorber temperature changes in dependence of the environmental factors, such as ambient temperature and solar radiation, but also by different operating conditions. During temperature fluctuations differences in thermal expansion, leading to local stress in the material, occur. The mechanical stresses of structural elements are studied with COMSOL Multiphysics®.

2. Use of COMSOL Multiphysics Software

To study the effect of deformations on real twin-wall sheets and their mechanical behavior the total stress in one point is calculated, consisting of thermal and mechanical stresses in this point (Formula 1).
σ= σ

Figures used in the abstract

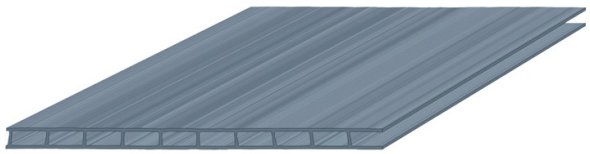

Figure 1: Schematic drawing of an extruded solar thermal absorber.

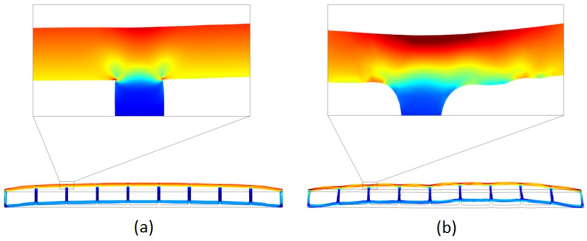

Figure 3: Stress distribution and deformation of an ideal absorber structure (a) and a real absorber (b) of PPS with a surface temperature of 338.35 K.