

## Task 4: Hybrid materials

**Instructions:** Check the following questions and exercises. Read chapters 11 and 12 in the 4<sup>th</sup> edition of the course textbook about hybrid materials.

**Criterion:** A good report on this task demonstrates a good understanding of:

- how materials can be combined in different ways to create structures that may be viewed as materials with a combination of the properties of the constituent materials (Task 4.1)
- the role of the geometrical arrangement of the constituent materials within a hybrid material, in determining the properties of the hybrid material (Task 4.2)

**Task 4.1:** For a greenhouse, the most amount of heat loss is through the gate. To be economical and consider sustainability, as well as the energy efficiency assessment, a greenhouse door made from a light and stiff sandwich panel structure, shall be designed. The basic need is a combination of stiffness, strength, low weight, low price, and thermal insulation. Estimate plausible dimensions and design loads for the door. Use the Hybrid Synthesizer tool in GRANTA to design the sandwich structure. Make sure that the materials you choose are generally available.

**Hint:** To make your design well demonstrated, try to consider the requirements, generating the objectives, constraints, and free variables. Step by step, all the necessary procedures for your selection methods, the explanation and derivation of the material indices, penalty function if there is any, diagrams, tables, etc. These shall all be included in your report for a better understanding.

One reference case example for you to think about: with dimensions of 2100 mm x 900 mm (height x width), thickness could be picked from a 10 mm to 100 mm range; a central load with 3.4 kN is applied to the door in terms of three-point bending (see textbook Table 11.3). When considering the thermal insulation of the hybrid materials, one simple assumption could be made that each layer is glued together as an assembly, so that the heat conduction passes through the thermal insulating layer easily. You are very much recommended to design the case with your desire and creativity.

**Note:** The synthesizer tool works with the level 3 Sustainability, Eco-design, Aerospace, Polymers, and Energy databases. Select suitable core and skin materials, as well as the core and skin thickness.

**Task 4.2:** Capacitive touchscreens work by sensing small electric charges from fingertips. Explain the material requirements for winter gloves intended to enable the use of a capacitive touch screen with these gloves. Design a hybrid material to achieve the desired combination of properties. Show your design and choice with diagrams and necessary explanations.

**Hint:** See *example 12.4: Extreme Combinations of Thermal and Electrical Conduction* as a guideline. If it is difficult to find electrical conductivity in GRANTA, you can also use 1/ electrical resistivity instead.