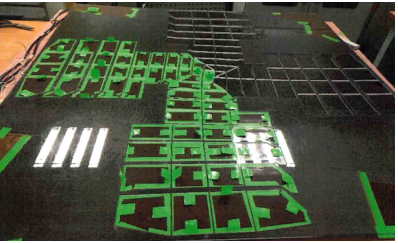
Multi-Matrix Fiber Composite Manufacturing Process

Fiber composites consist of high-tensile-strength fibers (e.g. carbon fiber) structurally embedded in a continuous-phase so-called matrix (e.g. epoxy). To produce a single connected object whose sections have different properties, such as flexible joints connecting stiff portions of a foldable device, different matrix materials must be combined. This invention provides a simple, highly flexible process for creating multi-matrix materials with custom geometries.



Realizing complex multi-matrix geometries with magnets

IP RIGHTS
European Application Filed
2024

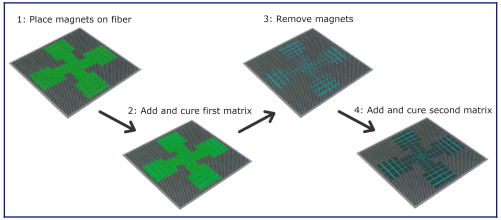
As a test use case, a foldable solar panel array for use on a CubeSat satellite was manufactured according to the invention. In order to be able to expand from a stowed volume of 10 cm x 10 cm x 10 cm to a deployed area of 110 cm x 110 cm, this array requires an intricate pattern of flexible border areas connecting the stiff sections where the solar panels are to be placed. (See figure below.)

01 Combine the strength of a single fiber backbone with areas of differing stiffness, thermal insulation or other differing properties.

02 Structure the product according to its function, not limited by the manufacturing process.

03 Use the same automated production line for various different geometries.

04 Test use case already implemented with a high degree of automation.



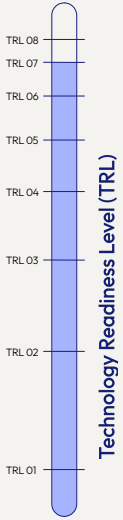
After placing the fiber sheet on a magnetic plate, magnets (in green) are distributed to cover the areas not to be soaked by the first matrix precursor material. Then the first matrix precursor (cyan) is added and cured before the magnets are removed. Finally, the second matrix (black) is added to the remaining areas of the sheet and cured.

CHALLENGE

In order to create a multi-matrix fiber composite with well-defined borders between the sections of different matrix materials, areas of the fiber sheet not to be soaked with the first matrix precursor material must be sufficiently compressed while it is applied. At the same time, all areas that are to be soaked must be reachable by the application tool. If the compression force is applied e.g. by clamps or a hydraulics, these requirements can be difficult to align, especially for more complex multi-matrix geometries.

INNOVATION

According to the invention, sheets of strongly magnetic material are custom-cut and placed on the fiber fabric to cover the areas not to be soaked with the first matrix precursor. By using magnets to apply the necessary compression force, no machinery has to remain in place above the fiber fabric while the matrix precursor material is applied, thus ensuring that all required areas of the fabric remain accessible. Moreover, with computer numerical control and suitable automation tools (water jet cutting, industrial robots), the same production line can be used for different products without any manual re-adjustment.



01 Basic principles observed · **02** Technology concept formulated · **03** Experimental proof of concept · **04** Technology validated in lab · **05** Technology validated in relevant environment · **06** Technology demonstrated in relevant environment · **07** System prototype demonstrated in operational environment · **08** System complete and qualified

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