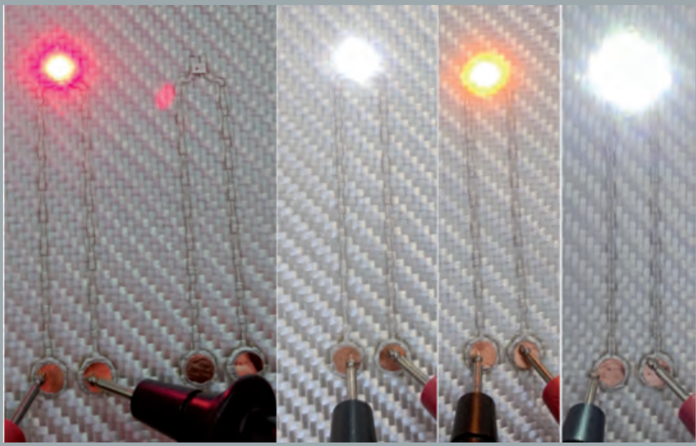
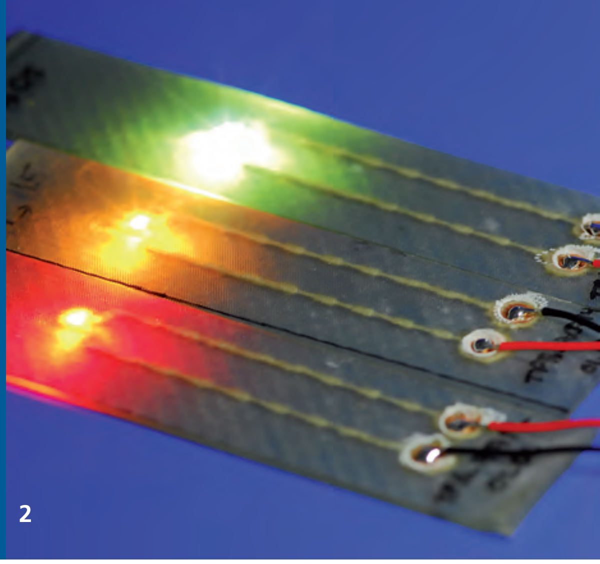


1



2

FUNCTIONAL INTEGRATION IN FRP WITH DIGITAL PRINTING

Glass fiber reinforced plastics (GFRP) and carbon fiber reinforced plastics (CFRP) are increasingly being used in lightweight construction due to their light weight and rigidity. However, they are often still produced in manual process chains entailing frequent variations in quality. Moreover, non-destructive testing methods suitable for FRPs are missing. Therefore, the advantages of these lightweight materials can currently not be completely utilized as any damages to the fiber structures, for example due to manufacturing or a hard impact during application, are rendered undetectable.

Structural components of FRP are therefore constructed with a large safety margin in order to ensure sufficient reliability, which leads to increased costs. Predictive maintenance during operation (structural health monitoring – SHM) can reduce the need for safety measures and thus save costs. In order to achieve this, sensors and the related electronics have to be integrated into the fiber composite structures. Ideally, damage would be detected not only on the surface but also in the component's interior, whereas the stability of the FRP itself must not be affected. The integration of very thin foil-based sensors is problematic, since these may in extreme cases lead to a delamination of an FRP component and thus to a failure of the FRP structure under higher loads.

In the sub-project B "Smart Wing" of the Fraunhofer lighthouse project "Digital Manufacture in Mass Production – Innovation for Series Production with Digital Printing and Laser Processes – Go Beyond 4.0", sensors and electronics for the monitoring of load conditions are integrated into and onto FRP components using digital printing processes. In this way, components can be exposed to high loads, while reliably - thanks to the permanent monitoring, any damages can be detected at an early stage. In addition, during the manufacture, sensors and actuators or even heaters and antennae can be integrated at relevant positions into an FRP component. Digital printing and laser processes allow us to print functional materials, such as sensor structures, locally onto an FRP surface, thus functionalizing a component. The integration of electrical, sensory, or capacitive functions within the fiber composite is also possible: Digital printing processes allow the direct application of functional structures with a high resolution to the fiber glass webs that are used as fabric layers in the manufacturing process of the fiber composite material. In the case of carbon fibers, these must first be electrically insulated. For this step, printing processes are suitable as well, applying insulation and barrier materials directly to the fibers. Following the printing process, the applied functional materials must generally undergo a thermal treatment, which occurs locally via laser or energy-rich UV radiation. The printed semi-finished textile materials can be directly implemented using conventional technologies for the manufacture of function-integrated FRPs.

1 *Tracks consisting of silver-polymer composite on glass fiber printed using a digital dispensing process; subsequent integration of LEDs.*

2 *Function-integrated LEDs in glass fiber plastic material.*