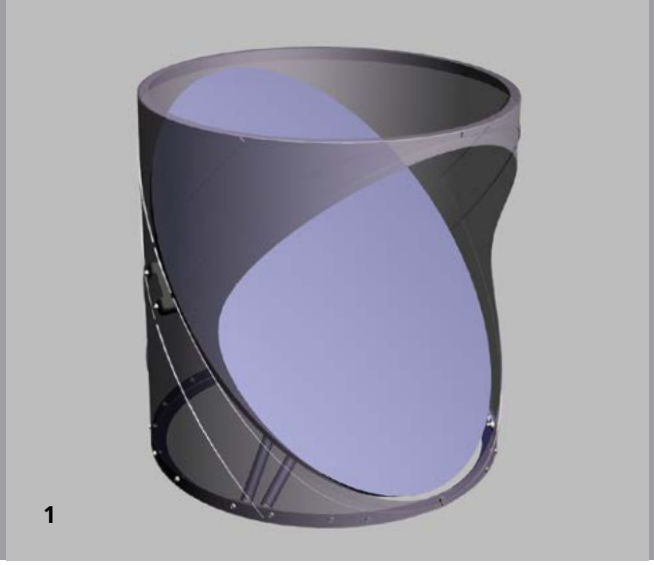

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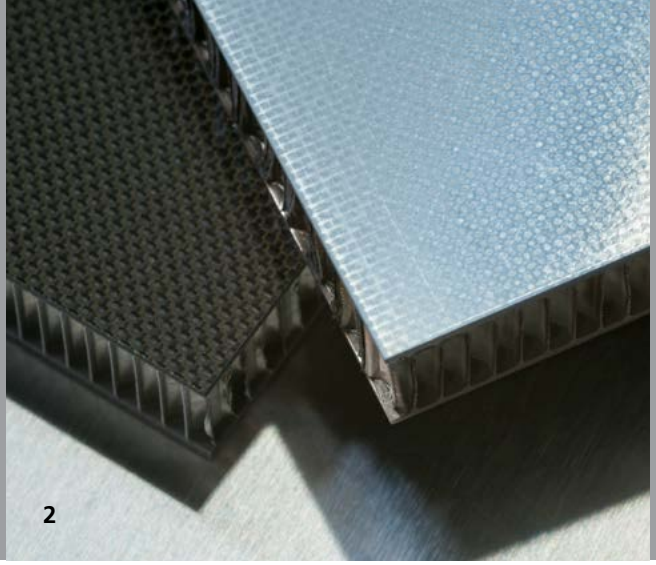

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FUNCTIONAL COATINGS FOR WEATHER SATELLITES

Precise and reliable weather forecasts can save lives and help to mitigate the global impact of weather disasters. For this reason, Europe's second generation of weather satellites – MetOp-SG – is equipped with various innovative high-performance research instruments. Accordingly, an improved highly sensitive radiometer for measuring microwave terrestrial radiation is to be used to determine air temperatures and water vapor concentrations at different altitudes. In addition to Airbus DS and Invent GmbH, the Fraunhofer IST is also a participant in this development.

Innovative, highly sensitive radiometer

At the heart of the radiometer for measuring microwave terrestrial radiation are innovative microwave reflectors made of a special composite material, a sandwich of carbon-fiber-reinforced plastic (CFRP) and aluminum honeycomb structures, which is characterized by a very low weight and at the same time a high rigidity. Critical to the function of the reflectors are suitable metal coatings, which allow an efficient microwave reflection. At the Fraunhofer IST the necessary coating systems and coating processes for CFRP components with dimensions of up to one meter are under development.

CFRP metallization by magnetron sputtering (PVD)

The challenge in metallizing the CFRP components is to lower the process temperature into an acceptable range for the CFRP composite material and at the same time achieve good bonding of the metal coating. The process developed at the Fraunhofer IST includes a wet-chemical cleaning procedure for the CFRP components, plasma pretreatment and the actual coating deposition by magnetron sputtering. Reflectivity measurements with a positive result and the first successful system tests with a coated reflector have already been carried out.

Silicon oxide protective layers (PACVD)

Since the reflectors are exposed to changing, in some cases extreme, environmental conditions during the course of their mission – from ground-launching of the rocket to arrival at the target orbit – it may be necessary to provide the metal coating with corrosion protection as well. This must not compromise the function of the reflectors. The approach taken at the Fraunhofer IST includes the development of a thin layer of silicon oxide (SiO_x) which is applied by a PACVD process after metallization. In addition to the usual plasma excitation in the kHz range, the use of microwave plasma sources in the GHz range is being evaluated. The goal is to provide a new coating process by more intensive plasma activation and the degrees of freedom gained in process control which optimally satisfies the various requirements deriving from the special CFRP composite.

Reflector coating with hybrid processes

For the combination of metal and SiO_x deposition in a hybrid process and for coating the reflectors, an industrial coating installation is available at the Fraunhofer IST which can handle components with a dimension exceeding one meter. At the

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collaboration partners Airbus DS, the new CFRP reflectors with the functional layers provided by the Fraunhofer IST initially undergo a qualification program and are subsequently to be produced for service in orbit. Data for the weather forecasting systems are expected to be ready from 2021.

The project

The contributions of the Fraunhofer IST to coating development and application to the satellite components fall within the framework of a project with partners from industry and science. The Airbus DS company is the central coordinator in the production of the high-performance research instruments for Europe's new generation of weather satellites. The CFRP composite reflectors to be coated by the Fraunhofer IST are manufactured by Invent GmbH.

1 *An elliptical microwave reflector with a dimension of about 600 mm.*

2 *Special CFRP composite material for the manufacture of microwave reflectors. Left: material in a raw state. Right: material after metallization and SiO_x coating by a PVD + PACVD hybrid process.*

3 *Industrial PVD + PACVD hybrid system with magnetron sputtering and microwave sources. Possible component size > 1 meter.*

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