LIGHTWEIGHT ANTENNA MATERIALS FOR THE INTERNET OF THINGS

Gerald Artner[a,b], Robert Langwieser[a]

[a]E389 - Institute of Telecommunications at TU Wien
[b]Christian Doppler Laboratory for Wireless Technologies for Sustainable Mobility

INTRODUCTION

The Internet of Things (IoT) aims at making a variety of devices accessible in networks. The most flexible way to connect such devices to a network is via wireless communication, such as wireless LAN or data services from mobile telephony. As part of their communication system IoT-devices must include antennas that allow reliable reception and transmission of electro-magnetic waves.

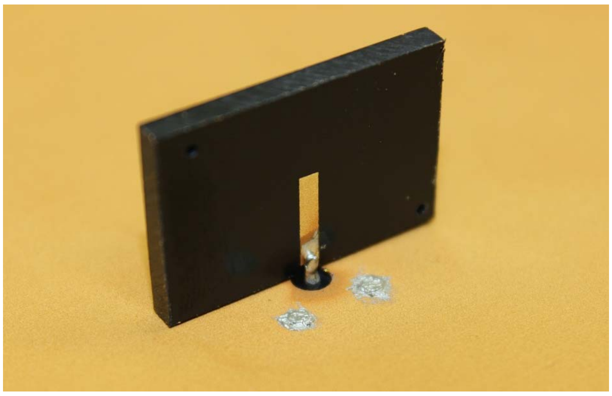

Fig. 1: Monopole antenna in LDS technology on a PC/ABS substrate mounted on an LDS ground plane.

Composite materials provide the mechanical stability for lightweight construction needed in many industrial and consumer devices. Carbon-fiber-reinforced polymers (CFRP) are increasingly used by mechanical engineers. Because the carbon-fibers are electrically conductive they are especially suited for lightweight antenna design.

Antennas for consumer devices and sensor networks in the IoT should be small. A process called Laser Direct Structuring (LDS) allows the metallization of plastic components and therefore conformal antennas as part of a polymer chassis.

MEASUREMENT OF ANTENNAS ON CFRP AND LDS GROUND PLANES

The availability of an electrically conductive sheet such as a CFRP chassis can be utilized as the ground plane for antennas in monopole or patch antennas.

A monopole antenna (Fig. 1) for intelligent transportation systems was fabricated with the LDS process. The radiating element for 5.9 GHz is a ~10 µm thick layer of copper, nickel and gold on a XANTAR LDS3720 PC/ABS substrate.

Three monopole antennas are mounted on rectangular ground planes made of aluminium, CFRP and one manufactured with the LDS, each with a side length of 150 mm. The antennas are measured inside the institutes' anechoic chamber (Fig. 2). To further reduce the influence of the measurement environment, the antenna under test is placed on a column of Rohacell. This material has a permittivity similar to air, even at high frequencies. Results are obtained with a near-to-far-field transformation.

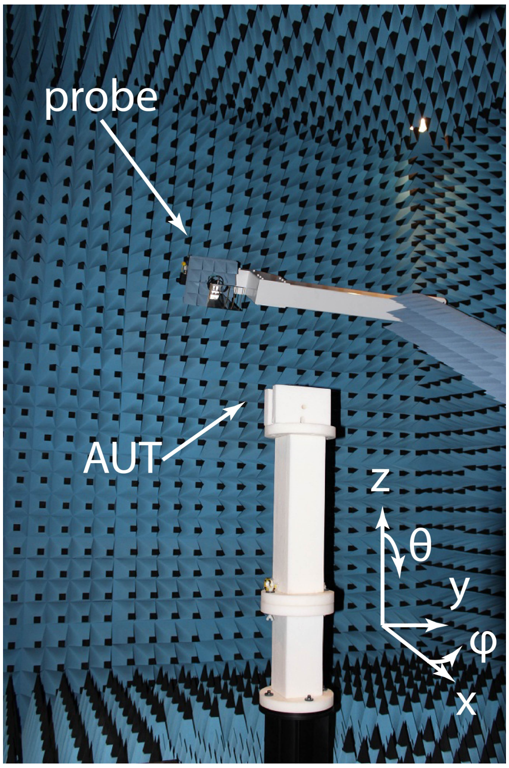

Fig. 2: Antenna under test (AUT) inside the institutes' anechoic measurement chamber.

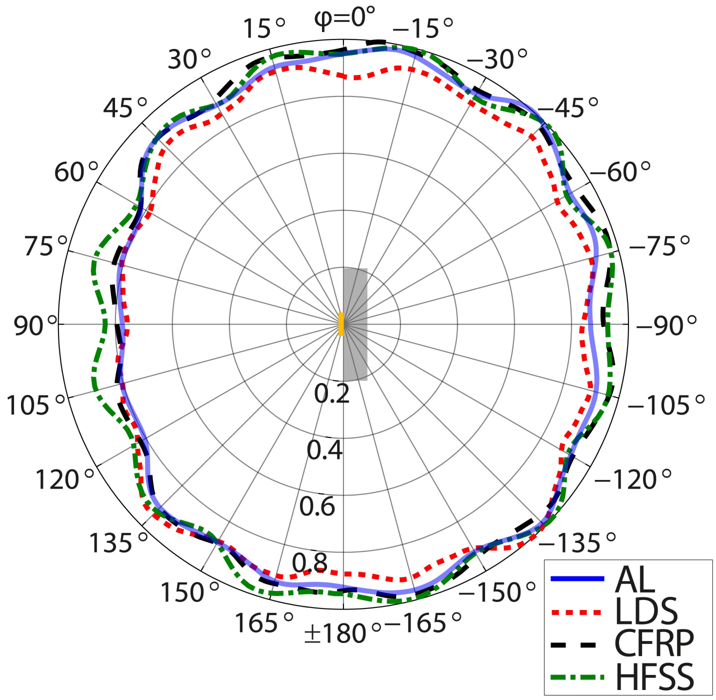

Fig. 3: Radiation pattern of LDS monopole antenna on aluminium (Al), laser direct structuring (LDS) and carbon-fiber-reinforced polymer (CFRP) ground plane; simulation in HFSS with perfect conductive ground plane. [1]

A horizontal cut of the antennas radiation pattern on different ground plane materials is depicted in Fig. 3. The LDS and CFRP ground planes are compared to aluminium, as it is a good electrical conductor and widely used as construction material for IoT devices. Additionally, simulation results for a perfect conductive ground plane obtained with Ansoft HFSS are shown. The radiation patterns of the antenna are similar for all considered materials.

Measurements have shown that on the CFRP ground plane the radiation efficiency is about 80 % relative to the efficiency on an aluminium ground plane.[2] On a polymer ground plane metallized with LDS 96 % efficiency relative to aluminium can be achieved.

CONCLUSION

Carbon-fiber-reinforced polymers (CFRP) are a suitable material for antenna ground planes and offer high mechanical strength for lightweight construction. Radiation efficiency can be increased with metallized polymers. Lightweight construction of devices and their antennas can substantially increase the number of devices that can be connected in the Internet of Things.

REFERENCES

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