Sustainable RF Applications using Laser-Induced Graphitization and Wood-Based Materials

Graduate

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Introduction: Sustainability plays an increasingly important role in all areas of technology and the field of wireless communications is no exception. Thus, it is necessary to assess the potential of renewable materials such as for example wood. It is well known that wood is naturally not a good conductor. This means that wood is potentially a candidate to serve as dielectric material in antenna designs.

Objective: The goal of this thesis is to investigate whether wood can be used in the field of wireless communications for example antenna designs. On the one hand by using wood directly as dielectric material and on the other hand by combining it with a laser-induced graphitization (LIG) process developed by the Institute for Building Materials at ETH in Zurich. The dielectric properties of the wood and the electrical characteristics of the graphitized surfaces are investigated. Simulations combined with measurements provide detailed insight for both the material characteristics and the evaluation of RF applications using wood as dielectric material.

Result: Despite the circumstances that wood is a challenging material to use in RF designs, due to its natural anisotropic behavior, it is shown that there are possibilities to use wood as dielectric material. This thesis shows two different approaches. On the one hand, wood is used to build a Cinnamon star-shaped dielectric resonator antenna, as shown in Fig. 1. On the other hand, the LIG process can be used to build electrically conductive structures on a wood substrate. With its rather high sheet resistance this surfaces are perfectly suitable to design RF absorbers based on the concept of frequency selective surfaces. An absorber is designed, built, and evaluated with a customized setup, as presented in Fig. 3. In Fig. 2 it can be seen, that the measurements show a good agreement compared to the simulation for different incident angles.

Figure 1: Handcrafted Cinnamon star-shaped dielectric resonator antenna, designed for 2.4GHz.
Own presentment

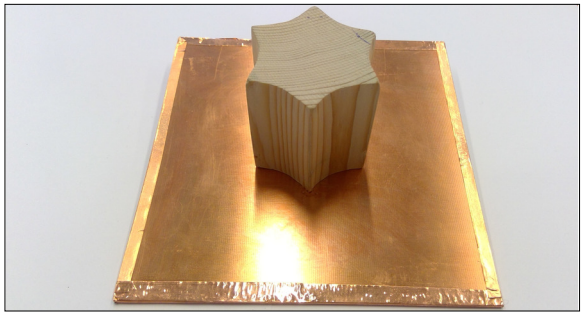


Figure 2: Reflection measurement of the absorber panel, compared to a copper panel for different incident angles.
Own presentment

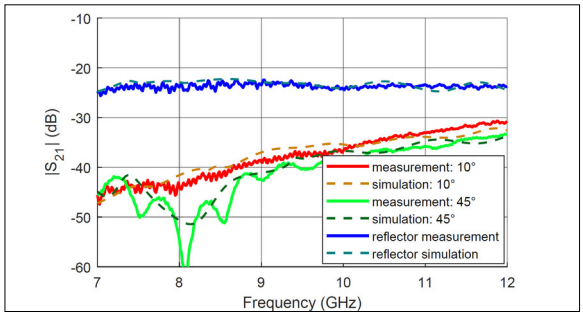
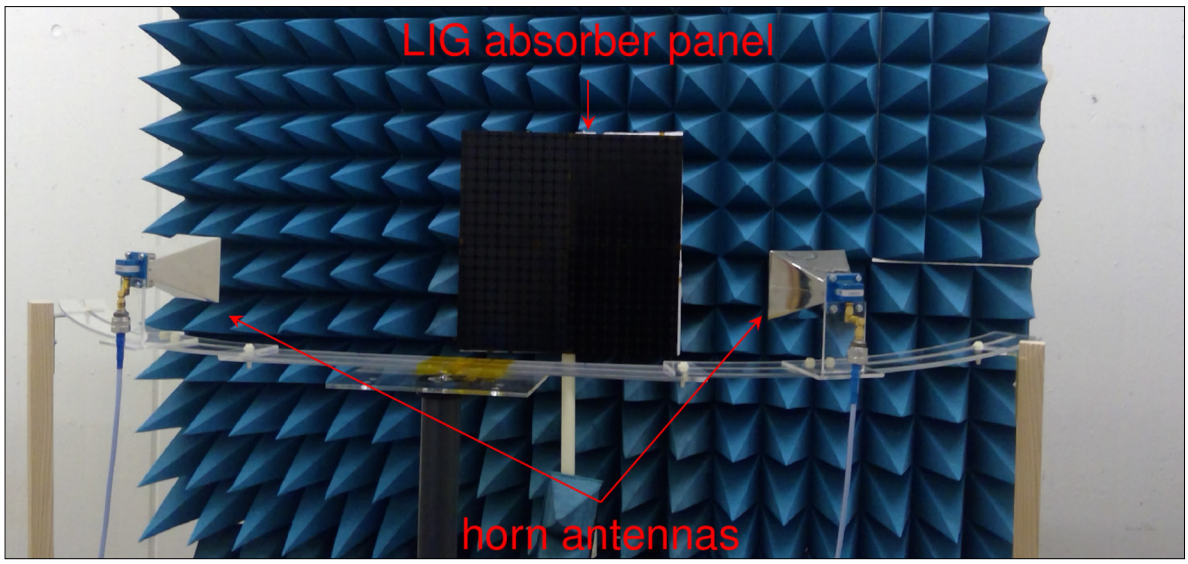


Figure 3: Custom built measurement setup to evaluate the LIG-based absorber.
Own presentment



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