This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 644039.

Newsletter / August 2018- Issue 7

M3TERA

Project Reference
644039

Start Date
1st of February 2015

End Date
31st October 2018

Duration
48 months

Project Total Costs
€ 4.255.743,75

EU Contribution
€ 3.742.961,25

Project webseite
www.m3tera.eu

Consortium
7 partners (4 countries)

Project Coordinator
Dr. Klaus-Michael Koch
coordination@m3tera.eu

Technical Leader
Dr. Franz Dielacher
franz.dielacher@infineon.com

Scientific Leader
Dr. Joachim Oberhammer
joachim.oberhammer@ee.kth.se

MICROMACHINED TERAHERTZ SYSTEMS

A new heterogeneous integration platform enabling the commercialization of the THz frequency spectrum

This work is supported (also) by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 15.0059. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Swiss Government.

Message from the Coordinator

The M3TERA project is approaching its final months, which also means that a lot of results are already visible. Final Thz Microsystem Prototypes for Telecom and Thz Sensor Prototype are available.
These are tailor-made for the need of the industrial end user Ericsson and the primary application of a Tx/Rx telecommunication link.
Further, a report on End-of-Life/Recyclability Analysis of THz-Microsystem Based Products for Telecom and Sensor Applications was completed and the key components are available now to test assembly. Most preparation tasks for assembly and test are completed, and ongoing tasks are on track.
Although the remaining time for accomplishing the final demonstrator system is limited, the final demonstrator is expected to be ready by the end of the project as planned.

Upcoming Events

Review Meeting
29th November 2018
@ Gothenburg, Sweden

APMC 2018
6th to 9th November 2018
@ Kyoto, Japan

End-of-Life/Recyclability Analysis of THz-Microsystem Based Products for Telecom and Sensor Applications

The M3TERA consortium finalized an analysis of End-of-Life/Recyclability of THz-Microsystem Based Products, summarizing the investigation of product life cycle and recyclability of high-volume products based on the proposed THz micro systems, including telecommunication and sensing applications. A baseline was set by giving a general introduction and definition of life-cycle assessment and waste generation in the European Union, as well as a short chart-up of current backhaul technologies.

The planned M3TERA platform, including updates of the proposed technology targets of the M3TERA terahertz micro systems over a state-of-the-art THz system, and its raw materials and components, is described.
Furthermore, first insight is provided into the telecommunication and sensing application. The M3TERA consortium provided an update of previous financial assessment and also charted the recyclability of raw materials and components of the M3TERA platform. A special focus was on the legal background and directives which are important for the recyclability of the M3TERA platform.
Finally, the material and resource reduction, as well as the linked cost reduction in comparison to conventional applications are outlined.

Life-Cycle-Assessment (LCA) was discussed in detail, focussing on the end of product life-time.

The consortium discussed Waste Generation within Europe and also studied Backhaul technologies.

The M3TERA consortium was able to conclude that M3TERA offers significant advantages in terms of volume, size and weight reduction. As a result, less waste will remain at the end of product lifetime. Assuming that about 5-15% of the stated products put on the market can be replaced by the M3TERA telecommunication link, and the proposed weight reduction by a factor of at least 1000, the potential total saved weight of waste sums up to a total of around 59.459 to178.376 tons per year.

In terms of recycling, several legal requirements have to be kept in mind, such as the WEEE Directive, the RoHS Directive and Waste Framework Directive.
The main difference and advantage is, again, the reduced size. Furthermore, the increased product life time leads to less waste and consequently, less environmental impact, fewer costs and a huge impact on the industry.

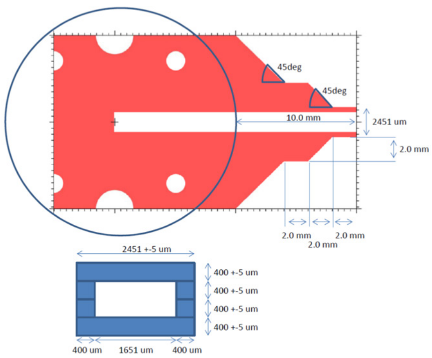
Product Life Cycle

Prototype of Fabricated and Characterized Sensor Interface

Different **low cost, plastic 3D-printed antenna solutions** mounted on micromachined-waveguide interfaces have been fabricated and characterized: **flat lens, rod**. As a reference, an open-ended micromachined WG was characterized as well.
The micromachined waveguide interface between the dielectric radiating bodies and a standard WR-6.5 waveguide flange were manufactured in a 4-layer stack consisting of 400µm thick micromachined chips, resulting in a 1651 µm x 800 µm large waveguide cross-section. The antennas are optimized to operate at mm-wave ISM band (122GHz-123GHz) and demonstrated to work for various RF sensing applications. The techniques used can be **easily extended to realize similar antennas** operating at other mm-wave frequency bands. Using a 3D printer, enables us to rapidly prototype different plastic antennas that can be mechanically fitted to transmitting devices and thus modify the radiation performances.
The tested **antennas demonstrated good overall radiation performance**. Slight deviation in the antenna performance is explained by possible misalignment attachment of the micromachined WG to the rigid WG section, as well as the antenna fixation in the WG and attached to the WG. Better resin material would improve the antenna rigidity and improve the antenna radiation performance if and when maintaining the same EM properties.

Michromachined Sensor Interface

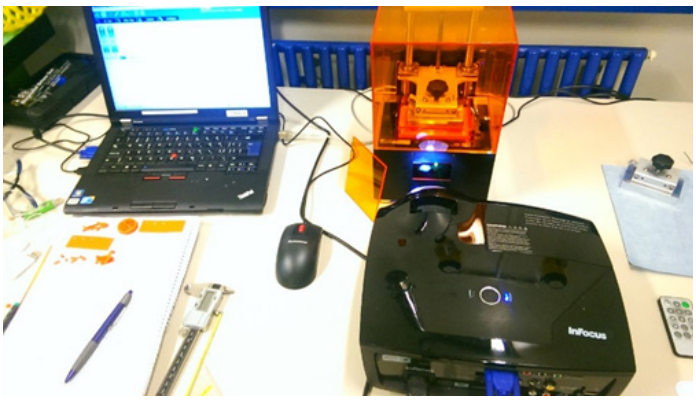
The sharp waveguide tip is achieved by multiple tapers in order not to compromise the mechanical stability, and thus make handling easy. One also sees the cross-section of the waveguide at the interface tip, showing the wall thicknesses in all 4 dimensions being 400 µm. It should be noted that the micromachined waveguide is slightly shallower than a standard waveguide, by 3.08%, which has a small but not a significant influence neither on the waveguide performance nor on the waveguide impedance.



Layout of micromachined-waveguide interface between dielectric radiating bodies and a standard waveguide flange.

Antenna Prototyping

The prototypes were implemented using a REIFY 3D printer. This is a stereo-lithography printer based on a Digital Light Processing (DLP) projector.



The antennas have been prototyped with better than 0.08mm accuracy

Rod antenna

3D flat lens

3D elliptical hemisphere

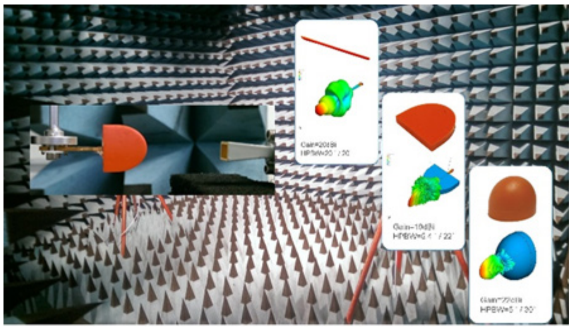
Prototyped plastic antennas

Antenna measurement setup

Commercially available transmitters/receivers were used in the measurement setup. The transmitter is equipped with matched standard horn antennas operated at dedicated frequency band (121GHz-123GHz). The transmitter is connected to an external LO generator, which is synchronized with LO generator and spectrum analyzer at receiver side. The antenna under test (AUT) is fixed on a rotatable (-90˚..+90˚) post mount. The antennas are measured in the vertical and horizontal positions.

The Micromachined waveguide (WG) section is connected to the available WR-10 (UG-387) flange waveguide section. Then, the micromachined WG section is fixed by two bolts and plastic rings. Plastic rings are used in order to protect fragile silicone structure.

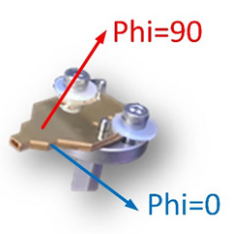
Two antennas were characterized: rod antenna and flat 3D lens antenna. The rod antenna is inserted into the micromachined WG, as planned. No further mechanical fixation is necessary. The lens antenna is attached to the WG with a small drop of plastic glue.



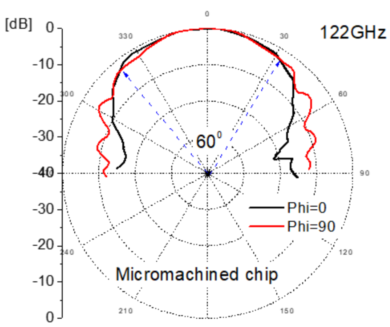
Antenna measurement setup

Antenna radiation performance characterization

The open micromachined WG antenna gain and Half Power Beam Width (HPBW) is about 6dBi and 50 degree accordingly. The measured antenna radiation pattern is very similar to the theoretical results.



Chip attached to the WG section

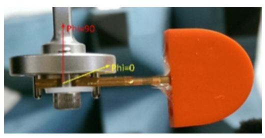


Measured Radiation Pattern

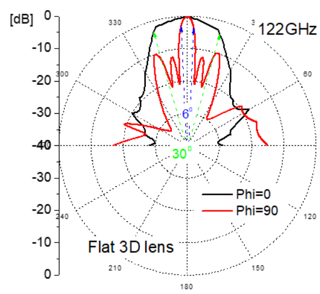
Micromachined waveguide radiation pattern measurement results.

The rod antenna gain and HPBW are respectively about 16dBi and 17 degrees. The measured antenna radiation pattern is slightly asymmetrical due to antenna geometry - The material of the antenna is quite soft which causes slight antenna bending. To avoid such problems in future, a more stable resin material with similar EM properties can be suggested.

The second 3D flat lens antenna demonstrated good radiation performance. The antenna gain was found to be about 17dBi, with a HPBW of 6 /13 degree. Major difficulties with respect to the characterisation of this antenna is the attachment and fixation of the antenna to the fragile WG section. In future, when the M3TERA platform is ready, the antenna can be attached to the main rigid chassis.



Flat 3D lens antenna



Measured Radiation Pattern

Flat 3D lens radiation pattern measurement.