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DEVELOPMENT OF INNOVATIVE COMPONENTS FOR LIGHTENING HIGH FREQUENCY DEVICES BY COMBINING ADDITIVE MANUFACTURING AND METALLIZATION METHODOLOGIES -

Session AM implementation and Industrialization

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AM PLATFORM European Technology Platform in Additive Manufacturing

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aiju Technological Institute for children's products & leisure

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Objective

ALFREC3D project aims to develop a novel manufacturing method through additive manufacturing (AM), metallization and integration of **high frequency devices** for use in **communication** systems, both **terrestrial and space**.

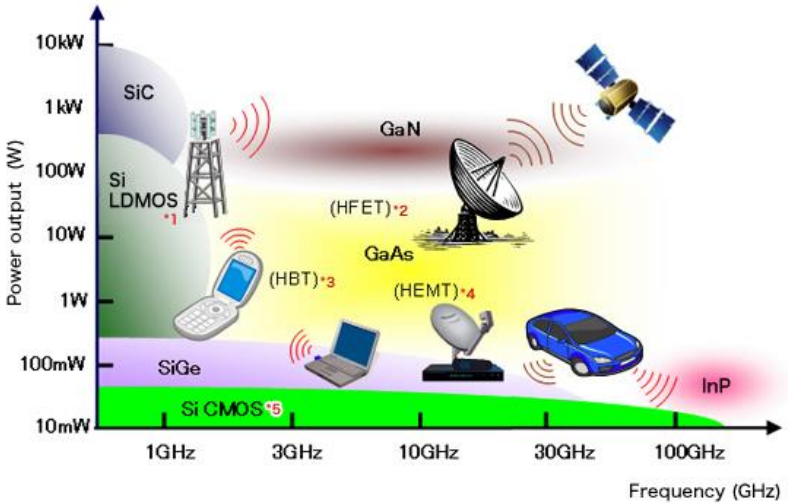

Figure 1. High-frequency device application fields

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Objective

The use of AM processes is a growing trend for this type of high-frequency communication devices:

- Antennas
- Transmission devices
- Receptor devices

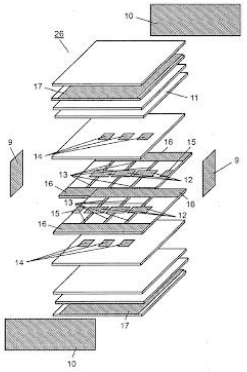

Figure 2. Different examples of high-frequency communication appplications

Advantages:

- Easy prototyping
- Low cost manufacturing
- Weight reduction

Figure 3. Polyjet AM technology

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Description

The new technique for the manufacture of high-frequency communication devices is based on three fundamental pillars:

- The use of **substrate integrated waveguide technology**, which allows the development of a very wide range of communication devices, such as transmission lines, filters, resonators, antennas, etc. integrated in a **planar substrate.**

dielectric lens horn
is a circular horn antenna (circular waveguide technology),
milled from metal material

Orthomode Transducer
example of a device that allows to receive and transmit separately
manufactured in rectangular waveguide technology
milled and welded in a metal block

A waveguide SLA
manufactured with good finishing

ESIW filter
technology integrated in substrate,
printed circuit boards, cut, metallized and stacked by welding and using screws.

Figure 4. Different examples of high-frequency communication devices and its manufacturing

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Description

- The second pillar is the use of **AM with polymeric materials** components, which substitute heavier metal ones.

- AM provides very high dimensional accuracy and low roughness surfaces (as higher the frequency, the lower the size of the device, then the higher accuracy is needed)
- The polymeric materials are subsequently plated by using a **technology patented** by UPV-CSIC[1].

The advantage of high frequency is that low surface thickness of conductive material is required

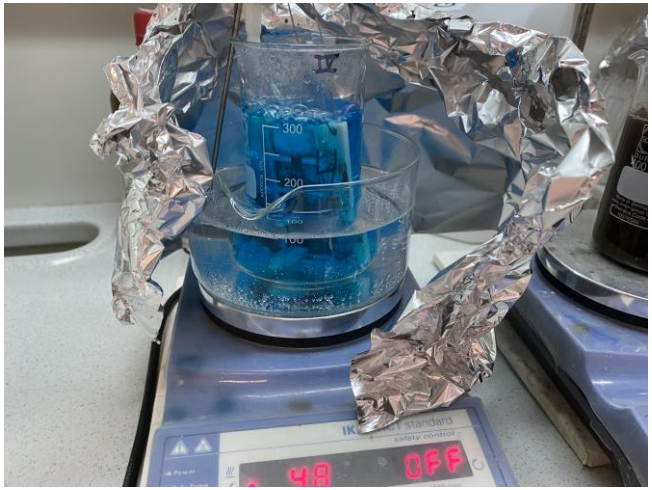

Figure 5. Metallization process

[1]*Manufacturing method for microwave devices based on empty substrate integrated waveguide.* Patent number ES201830647. PCT/ES2019/070426.

- The third pillar is the **modular integration** of the developed devices in a complex communication system.

The AM technology allows rapid and affordable fabrication of the devices adding fundamental advantages: flexibility and modularity.

It is allowed to integrate different devices into PCB and waveguide-based communication systems

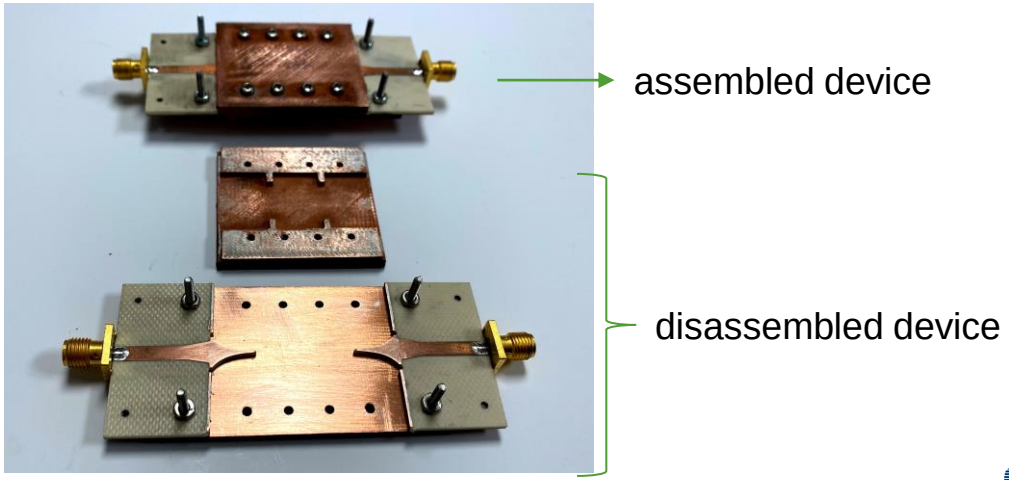

Figure 6. Integration of the different components

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Results

- First prototypes have been manufactured using Polyjet and SLA AM technologies
- Low profile waveguide integrated in substrate
- Standard WR75 (rectangular waveguide)
- Very smooth and flat surface achieved
- Dimensional accuracy suitable for the intended applications

- The metallization process achieves a **stable coating** of copper.

Only 15-30 microns on the polymer surface is enough to achieve good performance

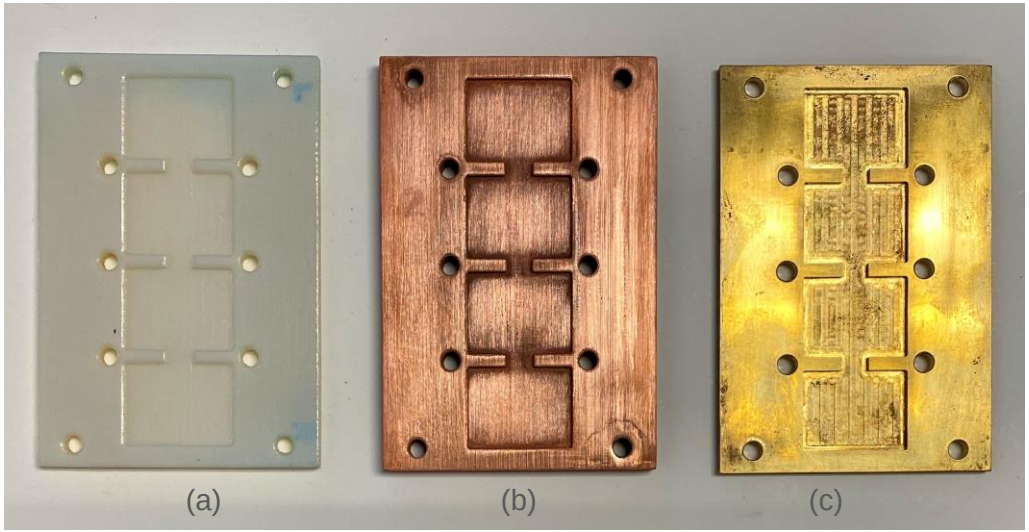

Figure 7. Manufactured devices: (a) Polyjet, (b) platted Polyjet, (c) conventional part (brass).

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Results

- **Weight** reduction **>90%**
- **Cost** reduction **>80%**
- **Time** reduction from **3-4 weeks to 5-6 hours**
- **Easy** to create a prototype or a final part
- No **loss** of material is produced
- **Surface and dimensional quality** and accuracy ≥ with conventional CNC manufacturing

Platted AM part vs Milled brass part

Figure 8. Platted AM part vs Milled brass part

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Work in progress…

- Measurement of AM parts properties:
  - Roughness
  - Dimensional control
  - Thermal testing to assess deformity with temperature

- Functional assessment
  - Integration – to study the integration in bigger systems
  - Measurement of electrical response

The devices must withstand the same conditions as conventional ones:

- Terrestrial, i.e. Temp.: 5-45 ºC
- Space: -60 to 120 ºC

without dimensional or conductivity performance alterations

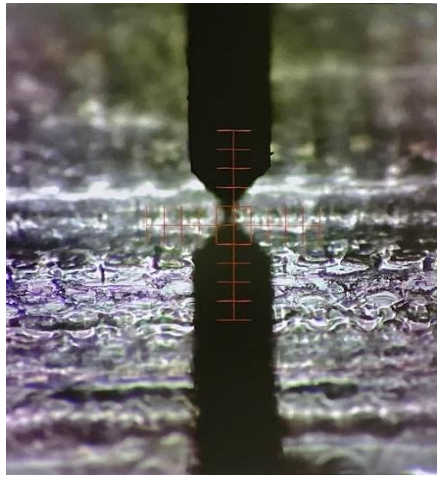

Figure 9. Roughness measurement

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Conclusions

- AM allows fast and cheap prototyping and/or manufacturing that facilitates the development of new devices and the access of research groups and companies to this business sector, which traditionally required large investments.
- The use of polymeric materials considerably reduces the weight, which is a key issue for space communication applications.
- The saturation of the radioelectric spectrum forces the use of increasingly higher frequencies, which means smaller devices that require great accuracy.
- The substrate integration enables the introduction of AM in planar technology, the most used for commercial applications.
- The modularity of the patented solution allows the replacement of damaged devices or the upgrade of systems.

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Consortium and role in the project

- UPV- Instituto de Telecomunicaciones y Aplicaciones Multimedia.

Design, development and integration of High Frequency Communication devices

- UPV-CSIC. Instituto de Tecnología Química.

Metallization process

- UPV. Campus de Alcoi

Manufacturing

- AIJU Research Centre

Additive manufacturing and testing

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Acknowledgements

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Thank you for your attention
Questions

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