INNOSOC Case Study

(selected for Zagreb 2016; extended version)

Case Study title:

Microwave Sintering

Keywords: Microwave technology; Sintering; Microwave heating

H2020 challenge addressed by the Case Study: Climate action, environment, resource efficiency and raw materials

Introduction to the Case Study

This Case Study implies the participation of **multidisciplinary groups** to join their knowledge to create a new tool for **sintering novel materials with new and improved physical properties**. This Case Study will consist of an active search of different microwave applicators to sinter materials, including rectangular or cylindrical applicators, solid state or classical tube amplifier as well as susceptors.

Active applicators, including tuning devices and automatic control (PID) to control the sintering process, will permit to control the speed of sintering to avoid problems like sample-breaks. All these possibilities give to **microwave energy** the possibility of create new materials for **innovative and added value applications**. The Case Study will consist of:

- Searching for bibliography that describes the benefits of the microwave energy;
- Summarizing different applications of microwave energy, with focus on its use for communication;
- Analysing security aspects of microwave radiation;
- Describing, based on references, the latest trends of the microwave energy in the field of new materials with new added values.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how novel materials with new and improved physical properties can be sintered. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during INNOSOC Zagreb 2016 workshop in late April 2016.

How this Case Study is related to the selected H2020 challenge?

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One of the H2020 challenges is the **"Climate action, environment, resource efficiency and raw materials"**, where the "design" of new materials is one of the main challenges in order to reduce the use of natural resources, to recycle the waste materials as well as to study the possibility of obtaining new materials with new characteristics in terms of speed of sintering, hardness and weight. With this in mind, is quite clear that, apart from the traditional ways to sinter materials, new procedures are needed that can reduce the energy used to create it or to improve the mechanical properties acquired by traditional methods. This is where **microwave technology** can help.

How this Case Study is related to the INNOSOC project?

INNOSOC project involves four main topics in its aim: "innovation" as a core topic; intercultural topics, with focus on "multicultural teams"; ICT topics, with focus on "innovative engineering based on ICT"; and student projects, with focus on "case studies on how ICT can contribute to innovative societal development". This Case Study covers all of them.

First, it is clear that this Case Study implies an **innovation** because not only it covers one of the H2020 main objectives but it is also using new technologies (like microwave heating) to design novel materials improving current properties as an alternative to the classical methods based, typically, on big ovens heated by traditional methods.

Multiculturalism is covered by the design of the working groups and a big number of partners participating in the INNOSOC project, coming from 11 universities from 8 different European countries, including former East and West countries that provides even more multiculturalism to the project.

Third, **ICT** is covered due to the proposed technology – microwave technology – that represents the basic technology for lots of ICT projects. While microwave technology is usually connected with spectrum used for communications other applications as the one proposed here are possible as well (more than 60 years ago the first microwave oven appeared).

And, finally, the **student project** is covered by this Case Study itself.

Questions that need answers during the Case Study development

- What does microwave technology mean for you?
- What are the traditional uses of microwave technology?
- What is the history of the microwave heating?
- What are the main uses of microwave ovens (microwave heating engineering)?
- Which are new applications of microwave technology (including drying food)?
- What are new sintered materials developed by microwave energy?
- What are new and advanced properties obtained with this technology?
- What possibilities exist for data storage, visualization and analysis of human activity and health parameters? Outline pros and cons.

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- How popular are pervasive and mobile applications for activity monitoring and daily life assistance and what is the state of tele-health or health-related services and information via telecommunications technologies?

References

[1] John M. Osepchuk, "A History of Microwave Heating Applications". IEEE MTT, Vol. 32, No. 7, Sept. 1984, pp. 1200-1224
[2] The web about microwaves: http://www.microwaves101.com/
[3] Proceedings of the AMPERE Conference 2015 in Krakow (Poland)
[4] Proceedings of the 2nd Global Congress on Microwave Energy Applications, 2012 in Long Beach, California (USA).
[5] Journal Ceramics International (http://www.journals.elsevier.com/ceramics-international/)

Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

to have taken courses in microwave theory (P); to have taken courses in electromagnetics (P); to be able to summarize all technical information about the topic in a document with the minimum number of formulae and more description and basics for non-familiar people on microwave technology (D).

Figures describing this Case Study

Figure 1. Uses of microwave energy

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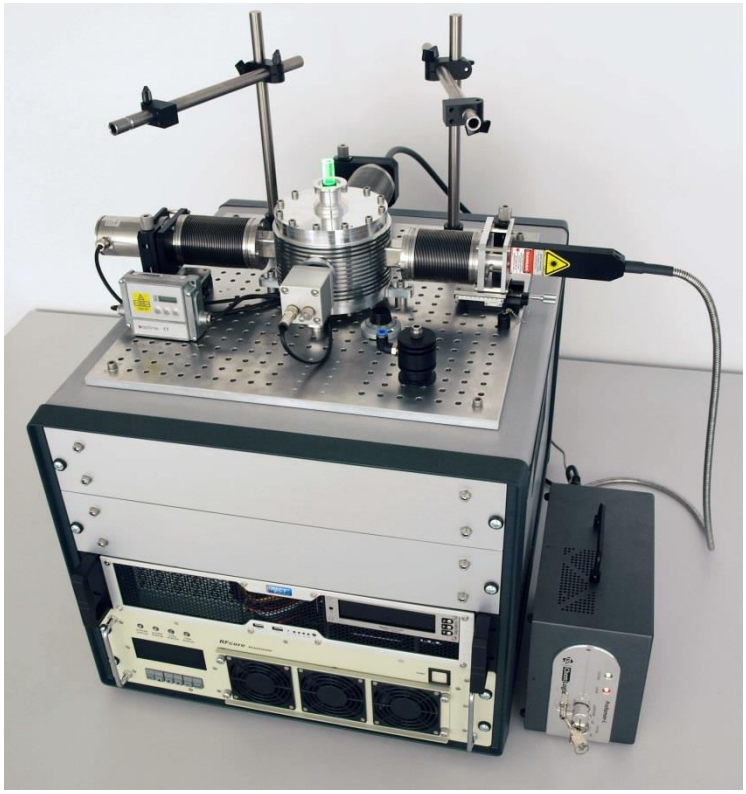

Figure 2. Microwave device for material sintering

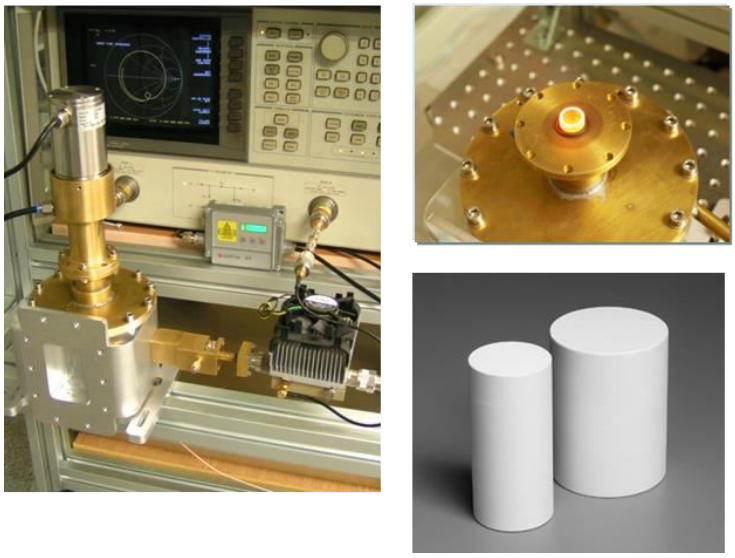

Figure 3. Materials sintered by microwave energy

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