Employment of High-Frequency ELectro-Magnetic Technologies for Competitive Processing of Ceramic Matrix Composites and Graphite Expansion

February 2016

INSIDE THIS ISSUE

HELM

Grant Agreement No.: 280464

Programme acronym: FP7-NMP

Topic: *NMP.2011.4.01 New technologies based on physical processing of materials for mechanical or electrotechnical applications*

Start date: June, 1st 2012
End date: May, 31st 2016

EU contribution: 7,151,000 €
Total cost: 10,285,626 €

EDITORIAL

Dear readers,

thank you for your interest in the HELM Project. In this fourth newsletter you find:

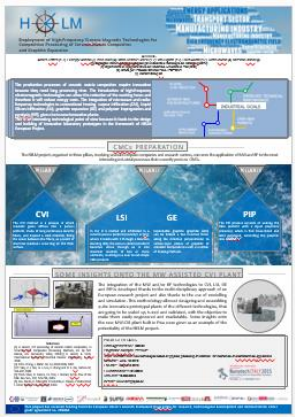
- The most recent achievements of our research
- Two inside stories about HELM technology providers and users
- A brief report on our last meetings and project review
- An outlook on the future meetings and some interesting events

I hope you enjoy reading this and thank you for any feedback you want to give us.

Andrea Lazzeri
Project Coordinator
a.lazzeri@ing.unipi.it

SPECIAL POINT OF INTEREST

New poster!



TECHNICAL BACKGROUND
CMCs preparation

PILLAR I

CVI

The CVI method is a process in which reactant gases diffuse into a porous preform, made of long continuous ceramic fibers, and deposit a solid material, filling the space between the fibers, as a result of chemical reactions occurring on the fiber surface.

PILLAR II

LSI

In LSI, Si is melted and infiltrated in a ceramic porous preform (usually C or SiC), where it reacts with C through a Reaction Bonding (RB); the porous ceramic preform becomes dense through an in situ chemical reaction of two or more elements, resulting in a near to net shape CMC product.

GE

Expandable graphite (graphite salts) can be dilated a few hundred times along the direction perpendicular to carbon-layer planes of graphite at elevated temperatures with a number of heating methods.

PILLAR III

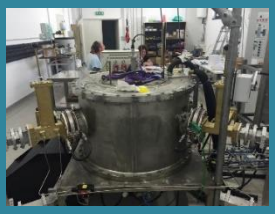
PIP

The PIP process consists of soaking the fibre preform with a liquid polymeric precursor, which is first cross-linked and later pyrolyzed, converting the polymer into ceramic.

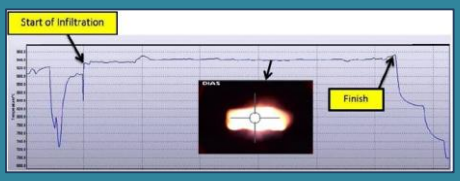
PILLAR I

Several weeks for the whole process, heating inhomogeneity (the surface becomes heated more than the core of the sample), high costs and low versatility in specimen geometry are the principal problems of the conventional CVI. The introduction of MicroWaves radiation could reduce process time at about one tenth. An hybrid MW-CVI plant, equipped with a system for dielectric properties and temperature monitoring, was built in Pisa (Italy) (Figure 1). The infiltration of SiC occurs in this kind of reactor at about 1000°C. Thanks to the integration of MW and conventional CVI heating, this temperature was successful reached and maintained stable for the entire infiltration time! (Figure 2)

1



2

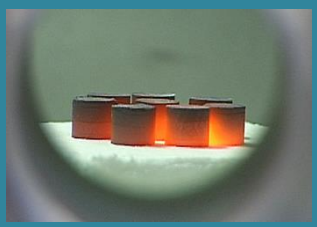


PILLAR II

In the first 18 months of the project, efforts in Pillar 2 were mainly devoted to the development of the MW furnaces, according to the requirements of the different end users (Petroceramics, BSCCB and Imerys). First trials with a labscale monomode MW furnace allowed to prove the feasibility of the MWLSI process. In the second period, the MW furnaces for LSI and GE were completed and delivered to SUPSI and Imerys respectively. After overcoming several technical problems, tests were carried out leading to positive results: for both processes, it was possible to produce materials (SiSiC and expanded graphite) with properties and microstructural characteristics which were very similar to those obtained following conventional production routes.

PILLAR III

The Pillar 3 of HELM is one of the three key technologies envisaged in the overall project. This pillar is addressing the low cost manufacture of ceramic matrix composites parts, by the reducing the processing time and energy consumption, for industrial, defense and aerospace applications. This is achieved by a the substitution of the conventional pyrolysis steps by means of a process based on MW heating, which is leading to a more suitable and effective way of heating, with a clear goal reducing the processing time by 60 % or more and energy consumption by 50–60 % for concurrent reductions in costs.
Building and sept-up of an up-scaled furnace for the MW heating of the PIP were carried-out. Simulations facilitated a design capable of achieving a uniform MW field. Very encouraging results are obtained which show the viability of microwave heating in PIP processing. Pillar 3 is also supported by parallel actions on design of experiments (in WP5) and life cycle analysis (WP12).



CERAMIC SAMPLES DURING MW-HEATING

PILLARS

ATL

ATL is a high tech UK SME with other 30 years' experience specialising in coatings and materials technology. A large part of ATL's business is research & development as CVD (Chemical Vapour Deposition) specialists with particular expertise in high temperature, low pressure coatings technology.

In addition our expertise also covers associated processes which include;

CVI…. Chemical Vapour Infiltration for use on porous materials
IVA… Isobaric Vapour Aluminising and
CVA… Chemical Vapour Aluminising

We have a highly qualified team with considerable experience in CVD, materials technology and chemical engineering and our expertise in this specialist area of research and development is sought after worldwide by those in the aerospace, nuclear, chemical and semiconductor industry.

HERAKLES

Herakles, missile and rocket propulsion specialist was created in May 2012, through the merger of 2 Safran Group subsidiaries,SME and Snecma Propulsion Solide.
Herakles designs, develops, manufactures and markets solid rocket motors, energetic materials and raw materials, as well as thermostructural and organic composite materials for defense, aerospace, aeronautics, automotive safety and industry.

Herakles offers proven excellence in the development and manufacture of high-tech aircraft parts. A pioneer in the application of composite materials to aircraft, including brakes and the propulsion system on the Rafale fighter, Herakles is now developing new applications. For instance, our ceramic matrix composites will reduce weight on the next generation of engines powering commercial airplanes, on turbines, nozzles, combustors, etc. Because of the exceptional properties of these CMCs, Herakles carved out a strong position in military aircraft very early in the game.
Dassault Aviation's Rafale multirole fighter is powered by the Snecma M88 engine, whose exhaust unit is assembled by Herakles. A key part of the engine, this subassembly is located at the afterburner outlet. Its secondary nozzle incorporates CMC flaps developed and produced by Herakles since 1995.

Herakles offers the full range of skills needed to develop new composite parts for civil aircraft, from original discussions with customers all the way to production.
Herakles provides services and products for strategic and tactical missiles and space launchers, equipment for aeronautics, safety automotive and industry.
Its expanded scope can offer its customers a range of complementary high performance products.
Present at 12 sites located on 3 continents, Herakles has 3000 employees.

PAST EVENTS

TC Meeting in Manno

On the 10th and 11th of December 2014, in Manno, CH, was held the 7th Technical Committee, the 4th Steering Committee and the 3rd Exploitation Committee at SUPSI, The University of Applied Sciences and Arts of Southern Switzerland.
SUPSI is the leader of Pillar 2, the technological pillar focused on high heating rate processing. In the field of materials science, SUPSI has been involved in many national and international projects aimed at the development, characterization and modelling of ceramic, polymeric and composite materials for high technology applications.
In the previous six-months period many activities were carried out by the partners and the meeting resulted to be a good opportunity to share the results achieved. It resulted to be also very fruitful for the planning of the forthcoming dissemination activities, which were discussed by the Exploitation Committee members.
During the meeting, Prof. Alberto Ortona welcomed the Consortium to visit the laboratories, where it was possible to see the MW furnace developed by FM, object of the experiments on Graphite Expansion that SUPSI is currently carrying out.

TC Meeting in Heuchelheim

On the 25th and 26th June 2015, in Heuchelheim, DE, the 8th Technical Committee and 2nd Industrial Advisory Board meetings were held, in the premises of SKT, SCHUNK KOHLENSTOFF-TECHNIK GMBH.
SKT is leader of WP6, dedicated to the process scale-up of MW-CVI for refractory materials and aerospace. SKT brings to the project an extensive expertise in the development and manufacturing of highly purified graphite, C/C and CMC materials.
During the first day of meeting, the consortium assessed the status of the project and planned the forthcoming months activities. The progress was positively considered and technical issues discussed. The partners had then the possibility to visit part of the company, the high temperature unit.
During the second day, the Advisory Board members Prof. Jon Binner and Prof. Walter Krenkel were invited to provide remarks and suggestions on the main issues of the three pillars - the meeting was indeed a perfect opportunity for cross-fertilisation of technological and scientific expertise.

Project Review and Exploitation Strategy Seminar in Munich

The HELM Project Consortium gathered in Munich, by AIRBUS Defence & Space premises, on the 17th of September, in order to attend the Exploitation Strategy Seminar, a brainstorming with project partners to launch an action plan for addressing identified HELM results to be exploited.
AGI - Airbus Group Innovations - that hosted the meeting, is leader of WP10, the WP dedicated to the MW/RF Pyrolysis process scale-up. AGI operates a global network of corporate Research & Technology laboratories that guarantee innovation potential with a focus on the long term in various domains including Composites Technologies.
On the second day of the meeting, the official second Project Review was held, with the attendance of the EC Project Technical Assistant, Peter Nagy. The status of the project was presented, showing promising and increasingly interesting results as the milestones were achieved, and the scale-up was underway. The Project Technical Assistant expressed a positive feedback, encouraging the consortium to conclude the activities with a high quality level.

FUTURE EVENTS

9TH TECHNICAL COMMITTEE, 5TH STEERING COMMITTEE, 4TH EXPLOITATION COMMITTEE

Partner: CIRCE
01-02 March 2016
Zaragoza (Spain)

FINAL MEETING & WORKSHOP

Partner: INSTM
30-31 May 2016
Pisa (Italy)

CONFERENCE AND EVENTS

JEC EUROPE 2016:
Paris| March 29-31/2016
www.jeccomposites.com/events/jec-world-2016

HIGH TEMPERATURE CERAMIC MATRIX COMPOSITES – HTCMC9
Toronto | June 2016 - Conference
www.ceramics.org

MICROWAVE MATERIALS AND THEIR APPLICATIONS - MMA2016
Seoul olympic parktel, seoul, korea |July 3- 6, 2016,
http://www.mma2016.org/main/ab_welcome.htm

CARBON CONFERENCE
Pennsylvania | July 10-15 2016
www.outreach.psu.edu/carbon

CONTACTS

PROJECT COORDINATOR

Andrea Lazzeri
a.lazzeri@ing.unipi.it
Tel: +39 0502217807
Fax: +39 0502217903

PROJECT MANAGER

Isella Vicini
isella.vicini@warrantgroup.it
Tel: +39 051 9840863
Fax: +39 051 9840885

DISSEMINATION MANAGER

Cinzia Iacono
cinzia.iacono@warrantgroup.it
Tel: +39 051 9840863
Fax: +39 051 9840885

HELM WEBSITE

HELM ON THE NEW SOCIAL MEDIA

If you would like to contribute an article or have any events that you would like us to include in the newsletter contact us at **info.helmfp7@gmail.com**.

If you would like to be added to the mailing list or no longer wish to receive the newsletter please email us at **info.helmfp7@gmail.com.**