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4M2020

Advanced Manufacturing of Multi-Material Multi-Functional Products Towards 2020 and Beyond

Instrument: Coordination and Support Action

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Objective of work package

Work package 4 has the following objectives:

- To identify one (or more) topic areas around which multiple partners can support and enhance the competitiveness of the EU industry and economy for the introduction and adoption of multi-functional miniaturized products in a range of sectors (for example, biotechnology, energy, medical opto-electronics etc.).
- Study the potential future financing mechanisms that may be available to support the development of the topic areas beyond the life of the CSA. This will include the projects themselves and the joint coordination of the projects
- Obtain commitment from the core partners and other stakeholders to progress the development of the projects at the end of the CSA, and to agree to joint coordination to maximize the impact and gain mutual benefit from future collaboration.
- Develop joint communication and dissemination routes during the CSA such that they can be easily replicated and continued at the end of the funding of the current CSA, and to ensure value added activity from collaborations instigated during the project.

Deliverable 4.2 reports

Deliverable 4.2 reports on the outcomes of the Foresight Forum that was hosted at Grenoble between 9th and 11th September 2014, the subsequent analysis of the funding theme areas identified compared with the first draft of the calls for the 2016/17 NMBP programme, and the results of a brokerage workshop, held on the 30th March 2015.

1. Development of the Foresight Forum and Publication of the Findings

The Foresight Forum was held between 9th and 11th September 2014 so that information could be gathered in time to provide an input to the drafting of the NMPB call for 2016/2017. Initial meetings were held with the development of the competence mapping (workpackage 2) in April 2014. As already reported in workpackage 2, almost 400 FP7 projects were reviewed, and this provided significant quantities of raw data to provide to the participants at the Forum.

Annex 1 provides the current version of the findings from the Foresight Forum. The process is explained in the document.

The Foresight White Paper sets out a number of funding theme areas, which were linked to previously generated roadmaps from NANO futures, MANUFUTURE, and Minam programmes. In early 2015 the first draft of the NMBP 2016/17 calls were available, and the opportunity was taken to compare the theme areas generated at the Foresight Forum with the first draft of the NMPB calls. Annex 2 is the report that was produced to make these comparisons.

2. Summary of the brokerage workshop

In line with the objectives of WP4, a brokerage workshop “**Higher Value production technologies and KET enabled applications**” was then held on 30th of March 2015, the day before the 4M/ICOMM 2015 Conference in Milano. The workshop brought participants from ten key FP7 projects in the field of 4M2020 that were completed recently or will finish in 2015. They constitute a representative cross-section of EC-funded projects that were identified based on the detailed analysis of more than 200 programmes in the area of 4M.



Fig. 1. The introduction of the open innovation principals that were used in organising the workshop and defining its scope

The number of attendees was 65 and twenty-one of them were stakeholders (constituting the technology/application providers at the workshop). It was important to establish the necessary working atmosphere and provide participants with access to much more detail information about the technology and application ideas promoted at the workshop. It is evident in Fig.1 that such an atmosphere was created successfully. A major contributing factor was that the participant were informed in advance about the workshop scope and objectives and also that the majority of the participants had already worked or considered before developing together novel ideas at the European level. During the workshop exploitable outcomes and ideas for follow up developments originating from the following EC projects were presented and discussed: 3D-HIPMAS, HIPR, SMARTLAM, MICRO-FAST, FABIMED, NEXTFACTORY, HINMICO, HYPROLINE and 4M2020.

The format of the workshop was specially designed to break the existing stereotypes in organising such technology/application take up events at the European level. In particular, in preparation for the workshop the organisers discussed with the Consortia of the participating projects the scope of the workshop, especially to promote tangible and proven project outcomes at TRL6 or higher and also to identify/propose ways forward to commercialise them. To achieve this, a new format for organising such workshops was conceived that clustered so-called "innovation pitches" of 5 minutes with a predefined content (see Annex 3) in sessions with common technology or application focus. This new format allowed the participants to identify technology and application areas/ideas of interest to them and quickly to judge/assess their potential for use in different product/application contexts including Rol

considerations. Annex 4 shows the detailed programme of the Brokerage Workshop together with list of attendees.

During the workshop 34 technology/application pitches were given. The pitches were clustered into two big sessions – Production (technologies) and Application. The pitches in the Production session were further grouped into four sub-sessions depending on their specific technology focus while the Application session into two sub-sessions. In particular, the focus of these sub-sessions was as follows:

Production session

- ✓ Inspection & Quality Control;
- ✓ Manufacturing technologies and Materials;
 - Injection Moulding,
 - Materials,
 - Surface treatment,
- ✓ Manufacturing Platforms;
- ✓ Assembly;

Application session

- ✓ Biotech and Healthcare;
- ✓ Components and Systems;
 - Communication,
 - Energy,
 - Ambient Living/Entertainment.

The readiness level of all presented technology/products/applications was high then TRL6 (**System/subsystem model or prototyping demonstration in a relevant end-to-end environment**). The main characteristics of the presented technology and application exploitable project results were:

- Pilot implementations on full-scale realistic problems;
- Partially integrated solutions with existing systems;
- Limited documentation available;
- Engineering feasibility fully demonstrated in actual system application;
- The maturity level of all developed technologies was high then MCRL7 (Capability and rate confirmed via economic run lengths on production parts.)

Such level of maturity of technologies and applications assumes a clear decision of all technological steps in the production chain and advanced readiness for pilot lines and manufacturing. This triggered open discussions about different ways forward with input from stakeholders along the technology/application innovation chains.

Closing remarks that summarise the put forward technology solutions and products was given by Prof. Stefan Dimov. In particular, his talk laid down key technologies together with their underpinned products/applications that are expected to have high impact in near future, according to the presented pitches.

Outcomes of the workshop

The workshop presented technologies at TRL6 or higher that were demonstrated or were expected to underpin existing and new emerging products in the following **high-impact application areas**:

Biotech & Healthcare:

- Customised microsystems - Micro-sensors, BioChip-C, etc. – **NextFACTORY**
- Lab-on-the-chip systems – **SMARTLAM**
- Orthodontic products: multi-material dental brackets – **HINMICO**
- Micro-switches based on the MID technology - **3D-HIPMAS**

Components & Systems:

- Polymer-based passive MW devices – **HINMICO**
- MID-based hearing-aid - **3D-HIPMAS**
- MID-based Pressure sensors - **3D-HIPMAS**
- HiFi Cartridges – **HINMICO**
- Personalised LED devices in surgical tools – **SMARTLAMP**

The following technologies/products at TRL6 or higher underpinning the presented high impact applications/products were discussed:

Inspection & Quality control:

- Optical Coherent Tomography (OCT) combined with computer vision - **FABIMED**
- Model-based tools for stamping - **HIPR**
- OCT technology for 3D inspection
- Micro injection moulding of 3D parts: watches, surgical micro aid, printed heads - **Hi-Micro**
- Computer Tomography for online metrology
- Online metrology: speed (250 2.5D parts per min and 1 um resolutions)

Micro Injection Moulding:

- Micro injection moulding of 3D parts: watches, surgical micro aid, printed heads - **Hi-Micro**
- AM technology for uIM inserts
- High resolution and throughput uMoulding –**3D-HIPMAS**
- High precision ceramic moulding- Polymer Processing Viscous (VPP) Epoxy Gel Casting (EGC) and Gel casting (PDMS) – **FABIMED**

Materials & Surface treatment:

- Nanostructured powders for FAST sintering (SPS) and process – net-shape parts - **MICRO-FAST**
- Ceramic engineered ceramic powders for replications – **MICRO-FAST**
- Laser Direct Structuring (LDS) thermoplastics - LCP, PEEK and PPA - metal line with pitches 60 to 100 um - **3D-HIPMAS**
- Surface treatments and coating techniques for microtooling - **MICRO-FAST**
- Nano patterning of DLC coating for micro tooling - **MICRO-FAST**
- Laser polishing of 3D-printed parts – **HYPROLINE**
- Surface treatment and coating for microtooling - **MICRO-FAST**

Manufacturing platforms:

- Component technologies for flexible and scalable manufacturing - **SMARTLAM & HYPROLINE**
- Seamless data integration, hybrid manufacturing platforms – **SMARTLAM**
- Assembly + 3D Printing – **NextFactory**
- Component technologies for assembly - 3D-MID – **3D-HIPMAS**
- Cold micro-forming of metal – **HIPR**
- S2S high-precision lamination modules for pilot lines - **SMARTLAM**

Three type of joint ventures for developing further the application with their respective underpinning technologies were discussed:

- **Formation of partnerships along their innovation/value chains at the European level.** Follow up workshops to develop these ideas were discussed. The intention is to align such workshops with the VCs description defined at the 4M2020 Forum in Grenoble and also with the forthcoming H2020 calls.
- **One to one joint ventures for some technologies/products with multi-sectorial impact.** These discussions were off record and took place after the workshop. 4M2020 will try to follow their development as far as the confidential nature of such scoping talks allows.
- **Formation of partnerships at national level.** This was related to some national technology clusters and forthcoming national calls for industry led projects in Germany, France, Austria and the UK. To following the development of such partnerships 4M2020 will consider joining forces with national associations or the existing national structures to support such technology clusters.

In addition FOCUS partner cluster “High-precision Production Technologies”, leaflet presented in Annex 6, is proactive in inter-cluster collaboration in order to enhance the impact of the brokerage workshop. This Cluster brings together a critical mass of industry facing R&D programmes with common development objectives and complementary technologies to underpin a number of key application areas for Europe competitiveness.

Annex 1 Foresight Forum Findings

This annex is the report that was finally issued on the 26th February 2015. However, the first draft of the report was circulated to project partners, participants at the workshop, and to the Commission in November 2014.

To open Annex 1
click here>>

Annex 2 Comparison of Funding Theme Areas Proposed by the Foresight Forum and the Draft Call of the NMPB 2016/17 Programme

The annex provides the document that has been circulated to partners and the Commission that compares the theme calls proposed following the Foresight Forum and specific project areas given in the draft call of the NMBP 2016/17 programme

To open Annex 2
click here>>

Annex 3: List of Participants at the Brokerage Workshop

First name	Name	e-mail	Organization	Country
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Frederik	Hasnaes		DTU / ORTOFON	Denmark
Manfred	Prantl		ALICONA	Austria
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Timo	Wohner		DTU	Denmark
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Raffaele	Meles		MIME minuterie Metalliche	Italy

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N.N.	N.N.		Fraunhofer IPT	Germany
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Michal	Ruzovic		3R Teknik	
Jan	Siegarsma		Philips	The Netherlands
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N.N.	N.N.		Sunplugged	
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Martin	Hedges		Neotech Services MTP	Germany
Diego	F. Pozo		Micrux Technologies	Spain
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Annex 4: Brokerage Workshop Template

Industrial Workshop Template

INDUSTRIAL WORKSHOP Higher Value production technologies and
KET enabled applications, Milano, 30.03.2015

Project: [your project name]

Presenter: [presenters name]

please include the following on cover slide

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All projects are funded by the European Commission under
FP7 Cooperation Programme 

Slide 1: Features

- What is the Technology?
- What are its key differentiators and Unique Selling Proposition?
- Who are the expected/targeted customers/users?

Slide 2: Benefits

- What are the open issues/problems solved for customers/users?
- What are the benefits/gains of applying it in the context of specific applications?

Slide 3: Return on Investment

- What is the Business Model?
- What is the capital investment and recurrent costs (staff time, maintenance, etc.) associated with the technology?
- What are the customers/users' tangible benefits (economical - e.g. unit cost, throughput, new markets, etc.; societal - e.g. environmental, quality of life, etc.)?

Annex 5: Brokerage Workshop Programme (Milano 30th March 2015)

Joint "Factory of the Futures" workshop on precision manufacturing technologies

Higher Value production technologies and KET enabled applications

Milano, Italy

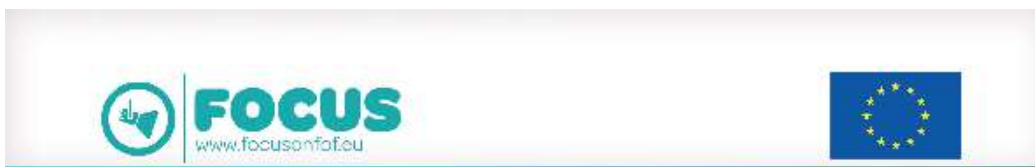
30.03.2015

sponsored by SMARTLAM and 4M2020

Time	Project No.	Project Name	Pitch No.	Title	Presenter	Organization	Country	
10.30				Welcome by the organizers and statement by the commission	Erastos Filos Markus Dickerhof Wögerer	European Commission Karlsruhe Institute of Technology University of Birmingham	Germany	
10.30				Overview on participating EC Projects	Andrea Pesarino	D'Appollonia	IT	
Production								
Inspection & Quality Control								
				Chair Markus Dickerhof, KIT	Rapporteur Andreas Buchsbaum			
10.50	1	HINMICO	30	Online quality control	Manfred Prantl,	ALICONA,	AT	
10.55	2	FABIMED	21	Use of OCT-CV on process and product quality check for polymer microreplicated parts	Andreas Buchsbaum	RECENTD	AT	
11.00	3	3D-HIPMAS	17	X-ray inspection tool for plastic based 3D carriers made by LDS technology	Sarkis RASTIKIAN	Plastipolis	FR	
11.05	4	SMARTLAM	36	Inspection Module	Christian Woegerer	Profactor	AT	
11.10	5	HIPR	2	Finite Element Methods as a mean to evaluate wear on tools	Ivan Tesfai	D'apollonia	IT	
11.15	6	HIPR	3	The OCT technology for 3D inspection	Andrea Pesarino	D-Apollonia	IT	
11.20		Discussion		Questions and filling of questionnaire				
Manufacturing technologies and materials								
Injection Moulding								
				Chair Christian Wögerer, Profactor	Rapporteur Graham Gross			
11.30	8	3D-HIPMAS	15	Finest metal lines on plastic based 3D carriers made by LDS technology	Stéphane DESSORS	PEP	FR	
11.35	9	FABIMED	22	High precision microrreplication of functional ceramics	Susana Olheiro	U. Aveiro	ES	
11.40	10	FABIMED	19	injection-compression moulding of nanotextured microfluidics	Daniel Vlasveld	PROMOLDING BV	NL	
Materials								
				Chair Christian Wögerer, Profactor	Rapporteur Graham Gross			
11.45	11	MICRO-FAST	8	Advanced Nanostructured powders for FAST technology and process	Alberto Colella	MBN Nanomaterialia SpA	IT	
11.50	12	3D-HIPMAS	18	New high performance LDS thermoplastics for fine pitch metal lines	Wolfgang EBERHARDT	HSG-IMAT	DE	
11.55		Discussion		Questions and filling of questionnaire				
Surface treatment								
				Chair Christian Wögerer, Profactor	Rapporteur Graham Gross			
12.05	13	MICRO-FAST	9	surface treatment and coating techniques for microtooling	Gonzalo Garcia Fuentes	Association Industria Navarra	ES	
12.10	14	FABIMED	20	Novel nanopatterning technology by ion implantation technology	Graham Cross	ADAMA Innovations	UK	
12.15	15	HYPROLINE	24	High throughput laser polishing of 3D sintered AM components	D. Bhaduri	University of Birmingham	UK	
12.20		Discussion		Questions and filling of questionnaire				

Manufacturing Platforms							
Chair Markus Dickerhof, KIT				Rapporteur: Nikola Vladov			
12.25	16	HYPROLINE	23	Novel Manufacturing Platform for Scale up Production of Miniaturised Parts	D. Bhaduri / P. Penchev	University of Birmingham	UK
12.30	17	SMARTLAM	34	Equipment for flexible, scalable Manufacturing	Markus Dickerhof	on behalf of FhG-IPA	DE
12.35	18	MICRO-FAST	7	Micro-FAST production system for volume production of miniaturized components	Alberto Colella	MBN Nanomaterialia SpA	IT
12.40	19	NEXTFACTORY	5	Integration of 3D-Printing, Micro-Assembly and Quality inspection technologies for the production of micromechatronic systems (extended)	Oliver Refle	Fraunhofer -IPA	DE
12.50	20	SMARTLAM	35	A software concept for seamless data integration in generative manufacturing	Nikola Vladov	University of Nottingham	UK
12.55	Discussion		Questions and filling of questionnaire				
Assembly							
Chair Christian Wögerer, Profactor				Rapporteur: Nikola Vladov			
13.05	21	3D-HIPMAS	16	Assembly of electronic components on 3D plastic parts	Wolfgang EBERHARDT	HSG-IMAT	DE
13.20	22	HIPR	1	The cold micro-forming of metal: new frontiers from HiPr project;	Stefano Baffetti	MIME	IT
13.25	23	SMARTLAM	32	Lamination Module for sheet to sheet based Pilot Lines	Norbert Schläfli	NSM	CH
13.30	Discussion		Questions and filling of questionnaire				
13.35-14.45 lunch break							
14.45 4M2020 open innovation concept					Helmut Loibl	Fotec	
Applications							
Biotech and Healthcare							
Chair Markus Dickerhof, KIT				Rapporteur: Sabino Azcarate			
15.00	24	NEXTFACTORY	6	Customized Microsystems based on the NextFactory One-stop-shop manufacturing system (extended)	Joachim Wiest	Cellasys	DE
15.10	25	SMARTLAM	33	Printed Electrodes for electrophoresis	Markus Dickerhof	KIT on behalf of Micrux	ES
15.15	26	HINMICO	28	Dental bracket	Sabino Azcarate,	EUROORTODONCIA	ES
15.20	27	3D-HIPMAS	13	Hearing aid device	Emilie FOND / Sarkis RASTIKIAN	Radiall / Plastipolis	FR
15.25	Discussion		Questions and filling of questionnaire				
Sensors and Energy							
Chair Christian Wögerer, Profactor				Rapporteur: Sabino Azcarate			
15.35	28	3D-HIPMAS	11	Micro switch device	Emilie FOND	Radiall	FR
15.40	29	HINMICO	29	Telecom diplexer	Sabino Azcarate,	FLANN,	UK
15.45	30	3D-HIPMAS	14	Pressure sensor	Emilie FOND / Sarkis RASTIKIAN	Radiall / Plastipolis	FR
15.50	31	HINMICO	27	Phono-cartridge	René Ersborg/Frederik Hasnaes,	ORTOFON,	DK
15.55	32	3D-HIPMAS	12	Assembly for fuel cell	Stéphane DESSORS	PEP	FR
16.00	33	SMARTLAM	31	Manufacturing of customized LED applications	James Gourlay	DesignLED	UK
16.05	Discussion		Questions and filling of questionnaire				
short break							
16.30	Final Rapporteur		Wrap up by rapporteurs and closure		Stefan Dimov	University of Birmingham	UK
16.45	end of workshop						

Annex 6: Leaflet of FOCUS partner cluster “High-precision Production Technologies”



June 2015, Leuven, Belgium – FOCUS partner cluster “High-precision Production Technologies”

The “High-precision Production Technologies” consists of in total 8 FoF projects, HI-MICRO, 3D-HIPMAS, HIPR, SMARTLAM, MICRO-FAST, FABIMED, NEXTFACTORY, HINMICO. With the support from the Commission, this cluster has been proactive in inter-cluster collaboration in order to enhance the impact of these projects. This Cluster brings together a critical mass of industry facing R&D programmes with common development objectives and complementary technologies to underpin a number of key application areas for Europe competitiveness.

On the 30th March 2015, a joint initiative – “INDUSTRIAL WORKSHOP Higher Value production technologies and KET enabled applications” has been successfully held in Milano, Italy. The participating EU projects are **HI-MICRO, 3D-HIPMAS, HIPR, SMARTLAM, MICRO-FAST, FABIMED, NEXTFACTORY, HINMICO, 4M2020, and HYPOLINE**. During this first joint workshop, both RTD institutions and industrial partners presented key results with high impact and of immediate relevance to industry. The participants at this workshop got not only an insight to the latest results of these industry-led ongoing R&D activities, but also more than 30 exploitable results presented in “innovation pitches”, each with a 5-minute highlight of key technical achievements and their potential for implementation in different product/application contexts.



During panel discussions and the coffee breaks participants were able to interact with the presenters, discussing business opportunities.

This activity has been appreciated by the Commission, and the project officer of 5 participating cluster projects, Dr. Erastos FILOS, has shortly joined the workshop through a Skype session.



Projects in cluster “High-precision Production Technologies”



HI-MICRO - High precision micro production technologies (www.hi-micro.eu)

The **HI-Micro** project intends to realize an innovative approach for the design, manufacturing and quality control of tool inserts, through further developing both enabling manufacturing technologies, including additive manufacturing (AM), micro electrical discharge machining (micro-EDM), micro electro-chemical machining (micro-ECM) and micro-milling, and unique metrology and quality control methods such as

