Stairway to Excellence

Cohesion Policy and the Synergies with the
Research and Innovation Funds

Example of Synergies

Research in novel materials with unusual electromagnetic properties - Institute of Electronic Materials Technology (ITME)

Poland

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Executive Summary

The combination of Framework Programme (FP), Structural Funds (SF) and national funding helped explore novel materials with unusual electromagnetic properties and wide-ranging applications in optoelectronics. The Polish research team managed by Prof. Dorota A. Pawlak from the Institute of Electronic Materials Technology co-ordinated the Framework Programme 7 (FP7) action and used their international experiences to further develop and patent innovative technological solutions. Structural Funds (SF) also helped acquire knowledge about commercialisation of research. The R&D results are being further improved using, among others, funding from the US Air Force, and researchers established an academic spin-off to commercialize their research results.

Type of synergies

- Downstream
- Sequential and parallel funding

S&T field targeted by the synergies

- Nanosciences and Nanotechnologies
- Materials

1. INTRODUCTION

The case presented in the following sections is one of the examples of synergies provided by the 'Stairway to Excellence' project in which different sources of funding have been combined to amplify the R&I investments and their impact on the economy and wider society.

As described in the guide 'Enabling synergies between European Structural and Investment Funds, Horizon 2020 and other research, innovation and competitiveness-related Union programmes[1]', synergies can be achieved through:

- Sequential (or successive) funding that use funds in separate projects built on each other;
- Parallel funding that use funds in separate projects complementing each other;
- Simultaneous/cumulative funding that brings together Horizon2020 and ESIF funds in the same project aimed at achieving greater impact;
- Alternative funding that reorients FP7/Horizon 2020 projects that were positively evaluated, shortlisted, but not funded given the limited budget, towards Structural Funds impact

The combination of sources of funding is used to address two types of activities:

- Upstream activities build the appropriate capacities to perform research. They can be capacity building in physical capital (construction or improvement of research infrastructures, purchasing equipment, (including IT equipment and connections, data storage capacities), innovation infrastructures (LivingLabs, FabLabs, Design factories, etc.) and social capital (assistance for building networks, clusters and consortia).
- Downstream activities are focussed towards the market and the creation of economic value. They can be applied to research, development and demonstration activities, technology transfer and adoption; technology and innovation audits to identify potential demand for RDI results; proof-of-concept funding; pilot lines for first production; and pre-commercial procurement projects. There can also be activities to support the improvement of the innovation eco-system in a territory.

2. CONTEXT

The research was inspired by outcomes of the FP-funded project "METAMORPHOSE" (2004-2008), which supported international networking of scientists interested in novel materials. Subsequently, Prof. Pawlak co-ordinated FP7 project "ENSEMBLE" (2008-2012), focused on empirical analysis of the so-called metamaterials (materials displaying properties not yet found in nature) and promoting international collaboration between European centres specializing in this emerging research field.

Subsequent stages of the research were funded from SF and national sources. One measure "TEAM", offered by the Foundation for Polish Science (FNP), helped establish a world class research team located in Warsaw. This allowed the Polish team to move from general work on metamaterials towards a more targeted analysis of development methods, properties and possible practical applications of advanced materials including patent applications.

One of the achievements was a novel method of manufacturing bulk plasmonic nanocomposites, having multiple applications in photonics. Researchers extended also the scientific body of knowledge related to eutectics (mixtures of alloys, which change the temperature of solidification

[1] http://s3platform.jrc.ec.europa.eu/documents/10157/267027/Guide%20on%20synergies_en.pdf

and melting). The developed eutectic structures could be used among others as photoanodes in photoelectrochemical cells.

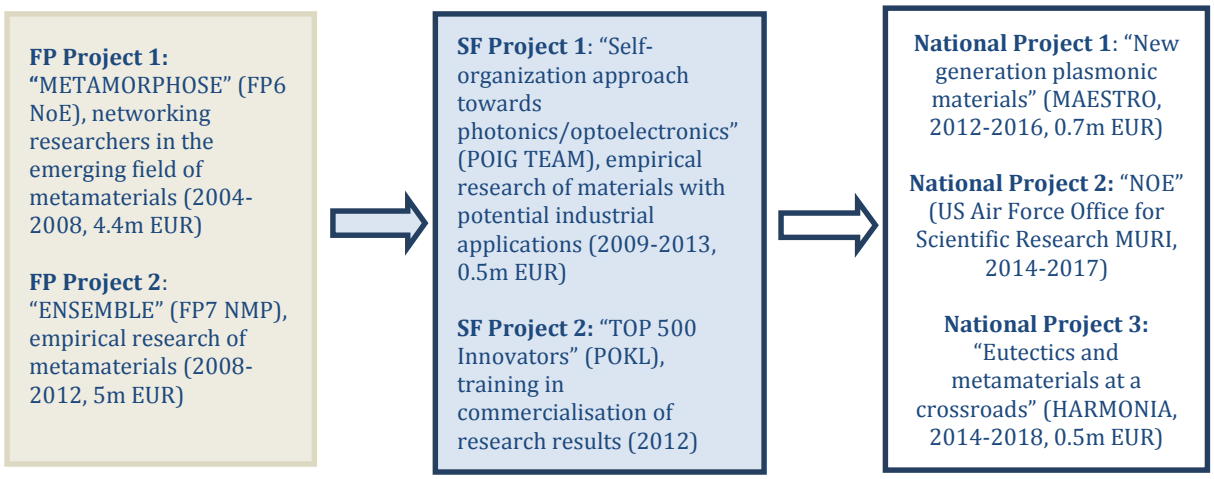
Another SF instrument, "Top 500 Innovators", opened up opportunities for science-industry collaboration and technology transfer thanks to a dedicated training programme in the US Silicon Valley. The research programme was further supported by national sources from Poland and the United States, as the US Air Force invited Prof. Pawlak's team to work on the development and applications of eutectics for metamaterials. This could be considered a particularly important recognition of research excellence, as the R&D support scheme is normally reserved for US universities.

3. Implementation

The implementation of synergies between FP and SF were facilitated by the creativity of researchers, combining multiple sources of finance and actively looking for new funding opportunities to expand the R&D efforts. The Polish government established dedicated support measures building on the successes of FP-based projects (sequential funding) as well as complementing FP projects co-ordinated by Polish institutions (parallel funding). The synergies and the projects involved in the synergies will be detailed in the following sections.

Figure 1 maps the project chronologically, the research activities of the organisation and the type of funding. It aims to give a picture of relations between projects revealing planned or unplanned dependencies (synergies) between projects and their source of funding.

Figure 1: Diagram of chronology of the main projects involved in synergies



Added value / complementarities created by the synergies

- Funding subsequent stages of research, allowing the exploration of an emerging technological field, moving from general searches towards a well-targeted analysis of development methods, properties and possible applications of advanced materials
- Support for international mobility, including collaboration with leading foreign researchers, becoming embedded in the Western research landscape and benefiting from the research commercialisation opportunities in the US Silicon Valley
- Ability to establish and maintain a world class research team, and promote career development of young researchers
- International recognition for scientific excellence

- Establishment of laboratory infrastructure required for advanced materials research, which can also be used in future research projects

As Professor Pawlak explained:

> "[*E]ach project had its specific advantages. The "NoE" project [FP6] enabled me getting to know the best people in the field and created an EU network in the area, with potential future partners. FP7 collaborative projects supported interdisciplinary research cooperation with the world-class scientists. It helped scientists learn from each other and influenced their further scientific lives. The SF project "TEAM" offered an opportunity to establish an international research team in Poland, and "Top 500 Innovators" allowed me to get acquainted with the research commercialisation practices at one of the world's top universities and helped me think out-of-the-box. The following, national projects supported continuous funding of my group's research. We've also recently established a spin-off company working on the commercial implementation of our research results.*"

Mechanisms/factors facilitating the synergies

- Creativity of researchers, capable of identifying and combining multiple sources of financing
- Careful selection of FP consortium partners, ensuring the right mix of skills and experiences, including a previous track record in EC-funded projects, research excellence and coverage of multiple, complementary research fields
- Support of the Brussels-based PolSCa (Polish Science Contact Agency, established by the Polish Academy of Sciences), helping better understand the expectations of the EC officers, which were not directly formulated in the FP7 call for proposals
- Availability of support measures directly complementing foreign funding in Poland ("TEAM" , "MAESTRO" and "HARMONIA" programmes)
- National co-funding for FP-based R&I projects carried out by public research organisations and "grants for grants" support scheme for project co-ordinators, preparing FP applications.

Main problems encountered in implementing the synergies

- It was felt that there was unequal treatment of FP7 consortium partners by the European Commission with a belief that only partners from new EU member states were subjected to an additional audit in the FP7 project
- H2020 regulations concerning researcher salaries lead to disproportions in budgets of partners from different EU members states, with partners from the Central and Eastern European countries receiving only symbolic remuneration in comparison with their Western counterparts, so Polish researchers need to look for other sources of national or international funding (e.g. from the US or private companies)
- Salaries of research team members need to be financed from multiple sources, as budgets of individual projects do not cover their entirety, and the requirement for project co-funding is problematic for a public research institute
- Challenges in finding suitable business partners for commercialisation of research results, resulting in the need to co-operate with the US Department of Defense agency instead.

Suggestions to improve the synergies

- The EC should promote the involvement of Polish researchers in H2020 by adjusting the salary levels so that project partners from different countries could have comparable budgets
- Facilitating SF applications and reporting to more closely resemble standards adopted by FP7/H2020
- Polish government should be more active on the EU level in H2020 programming

- Participation of Polish researchers in H2020 projects needs to be rewarded in ways similar to project-based compensation of scientists from Western European countries to retain the most skilled specialists in Poland
- Need for better administrative support for researchers at their home institutions, as well as recognition of scientists who secure external R&I funding and complete breakthrough research projects
- Need for stronger, local companies in emerging technology areas to support Polish researchers, looking for commercialisation partners.

Main motivations in implementing the synergies

- Funding further stages of the research to follow up the outcomes of previous projects and focus on the most promising novel methods and properties, identified earlier
- Exploring the international scientific network in the emerging, interdisciplinary field.

Facilitating mechanisms for the take up of the scientific results

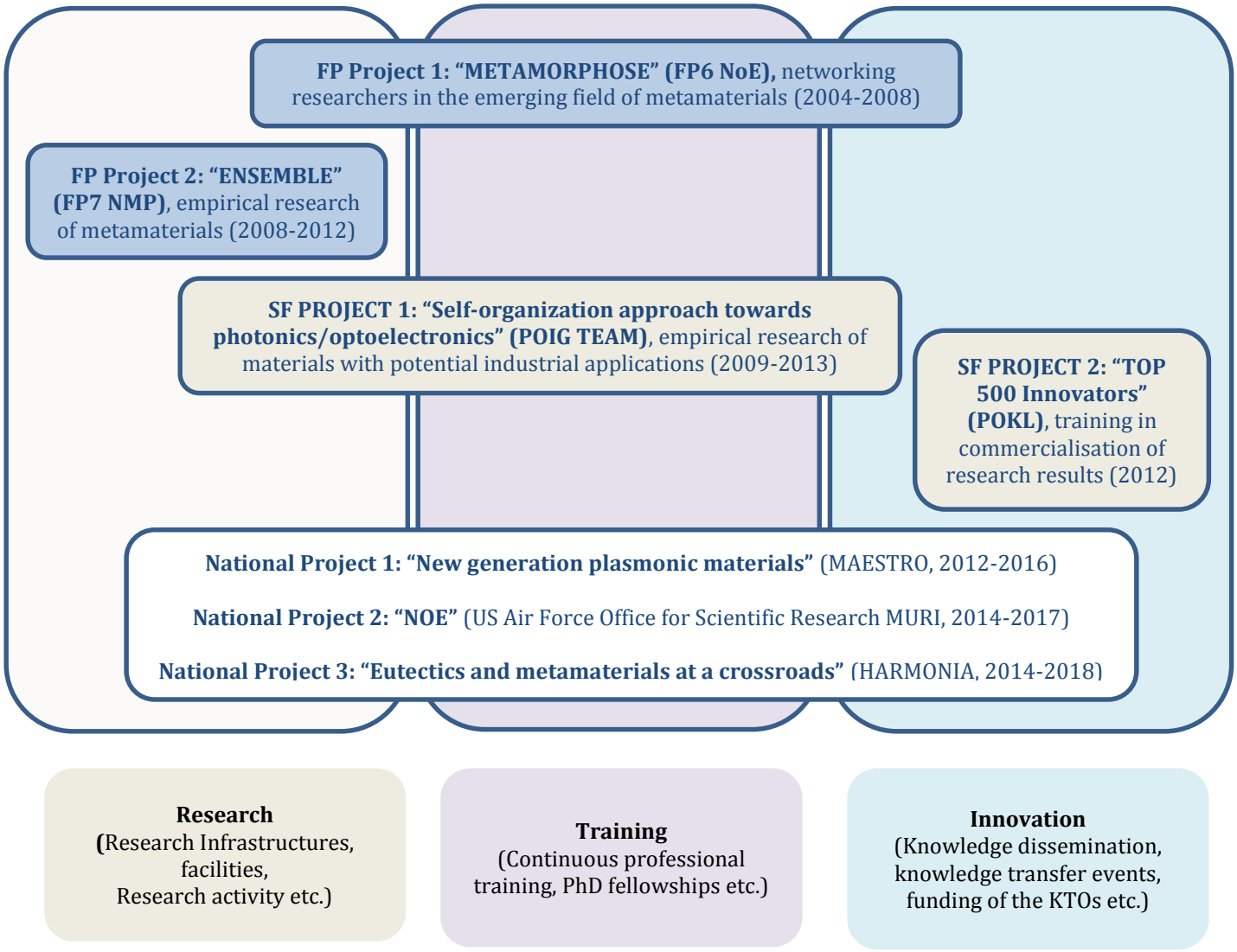
- Institutional funding allocated to scientific organisations based on regular assessments, taking into account research excellence, provides the bottom line for the Institute's operations and is supplemented by dedicated grants from multiple sources
- National regulations encouraging the establishment of spin-off companies, commercialising results of scientific research.

Impact on the regional / national economy

- Scientific reputation of the Institute as the leading research centre in the emerging fields of metamaterials and plasmonic materials, recognised among others by the US Air Force
- Development of innovative technologies and accumulation of scientific knowledge and intellectual property which will be critical for future commercialisation of metamaterials
- Establishment of a world class research team and ensuring the continuous research involvement of the team members.

Figure 2 aims to position projects according to the activities they cover; from upstream (infrastructures, equipment, research activities) to downstream related activities (innovation, knowledge transfer, access to market).

Figure 2: Diagram of the complementarities of the funds in the knowledge triangle / flow



4. Related Projects

Name of the FP PROJECT: "METAMORPHOSE - MetaMaterials ORganized for radio, millimetre wave, and PHOtonic Superlattice Engineering"

- FP funding scheme: FP6 "NoE" - Network of Excellence
- Budget: 4,400,000 EUR
- Time frame of the FP funded project: 2004-2008
- Main objectives and type of costs covered: The project, coordinated by the Helsinki University of Technology, focused on developing artificial materials, possessing features not found in nature, so-called metamaterials. With 21 consortium members from 12 countries, the project led to the establishment of a platform for international collaboration: the Virtual Institute for Artificial Electromagnetic Materials and Metamaterials, incorporated as a non- profit association (METAMORPHOSE VI AISBL), and Prof. Dorota A. Pawlak serves on its board of directors. The project helped the EC appreciate the importance of metamaterials and include the topic among FP7 calls. The project budget covered researchers' salaries and travelling expenses.

Name of the FP PROJECT: "ENSEMBLE - ENgineered SElf-organised Multi-component structures with novel controllaBLe Electromagnetic functionalities"

- FP funding scheme: FP7 NMP Collaborative project
- Budget: 5,088,075 EUR
- Time frame of the FP funded project: 2008-2012
- Main objectives and type of costs covered: The project, coordinated by the Institute of Electronic Materials Technology, originated from previous research of Prof. Dorota A. Pawlak and experiences from the preceding, FP6-funded initiative. 4 out of 8 consortium members from 6 countries participated in the previous project "METAMORPHOSE". The consortium combined theoretical expertise in metamaterials with practically oriented materials science. Research interests of the project team centred around the eutectics, i.e. composite materials with special structuring occurring when two or more phases from completely mixable melt grow cooperatively. The eutectic self-organisation mechanism, analysed in the project, enabled the development of multi-component, multi-scale structures, which had controllable physicochemical and structural properties, with geometrical motifs on the submicron/nanoscale, linked to specific, unusual electromagnetic properties. The team developed also 3D modelling tools and numerical simulation methods to predict the occurrence of specific patterns in eutectic structures. The budget included allocations for: research equipment, consumables, personnel costs, project management and travel expenses. National funding was available to cover the costs of preparing the grant application ("grants for grants" support of the Ministry of Science and Higher Education).

Name of the SF PROJECT: "Self-organization approach towards photonics/optoelectronics"

- SF funding scheme: "TEAM" (Operational Programme Innovative Economy POIG, support measure 1.2 – FNP, Foundation for Polish Science)
- Budget: 1 991 499,33 PLN (~ 0.5m EUR)
- Time frame of the project: 2009-2013
- Main objectives and type of costs covered: The project built upon the findings of the FP7 project "ENSEMBLE", and focused on selected characteristics of eutectic materials with high commercial potential in photonics/optoelectronics. Prof. Pawlak was particularly interested in using the materials to convert solar energy into other types of energy, and developing hybrid eutectics doped with nanoparticles, metal-oxide and semiconductor-oxide. Thanks to the project funding, a strong international team was established at the Institute,

encompassing postdoc, doctoral and graduate research positions. The project benefited from methods developed in the parallel FP7 project. Its results included the development of a novel method of manufacturing bulk plasmonic nanocomposites in a relatively simple and fast manner, with the ability of controlling their sizes, shapes and chemical composition, thus having multiple potential applications in photonics. Researchers also managed to demonstrate the giant Faraday effect in eutectics with terbium ions and extended the scientific body of knowledge related to the use of eutectics for photoelectrochemistry (generation of hydrogen utilizing stable eutectic structures as photoanodes in photoelectrochemical cells). Four patent applications for project-derived inventions were filed in 2011-2013. The project budget supported: research equipment, consumables, salaries and scholarships of researchers and international mobility.

Name of the SF PROJECT: "TOP 500 Innovators"

- SF funding scheme: Operational Programme Human Capital POKL, support measure 4.2 (MNiSW, Ministry of Science and Higher Education)
- Budget: NA
- Time frame of the project: 2012
- Main objectives and type of costs covered: The project stimulated R&I commercialisation and science-industry collaboration. Beneficiaries (including prof. Pawlak) attended a dedicated, 2-months training programme, commissioned by the Ministry of Science and Higher Education and delivered by the Stanford University, USA. The programme covered issues of entrepreneurship, R&D project management, team work, innovations, IPR, technology transfer and industrial design. It also offered opportunities for networking with the Silicon Valley community. According to Prof. Pawlak, the SF-funded project proved also helpful in further research efforts, as it "taught how to think out-of-the-box" and opened a new chapter in her scientific career. The project budget covered the course tuition and travel expenses.

Name of the nationally funded project: "New generation plasmonic materials"

- National funding scheme: "MAESTRO" (NCN - National Science Centre)
- Budget: 2,930,000 PLN (~ 0.7m EUR)
- Time frame of the project: 2012-2016
- Main objectives and type of costs covered: The national "MAESTRO" funding scheme is targeting the most experienced researchers and pioneer, breakthrough scientific research. Prof. Pawlak's project enriches the outcomes of the previous, FP- and SF-funded projects, related to the novel method of developing plasmonic nanocomposites. The modified method supports the doping of dielectric matrices with selected chemical agents and plasmonic nanoparticles with specific sizes, shapes and compositions, so that they resonate at particular wavelengths. The budget covers the costs of research equipment, consumables, personnel and international travels.

Name of the nationally funded project: "NOE: NOvel metamaterials and plasmonic materials properties enabled by directional Eutectic solidification"

- National funding scheme: "AFOSR MURI" (US Air Force Office for Scientific Research Multidisciplinary University Research Initiatives)
- Budget: NA
- Time frame of the project: 2014-2017
- Main objectives and type of costs covered: Based on the observation of successful results of "ENSEMBLE" and "TEAM" projects, the United States Department of Defence announced a multi-million dollar "MURI" funding initiative focused on the development and applications of eutectics for metamaterials. Prof. Pawlak was invited to cooperate with the successful "MURI" project on this subject: "Directional eutectic structures: self-assembly for metamaterials and photonics", which was a rare achievement for European researchers,

especially as “MURI” is dedicated for US universities. The collaboration with the US-based networks enables the Polish research team to better understand the ongoing developments and commercialisation efforts as well as benefit from the newest research ideas and results. The project budget includes: researchers’ salaries, consumables and international mobility.

Name of the nationally funded project: “Eutectics and metamaterials at a crossroads”

- National funding scheme: “HARMONIA” (NCN - National Science Centre)
- Budget: 1,975,064 PLN (~ 0.5m EUR)
- Time frame of the project: 2014-2018
- Main objectives and type of costs covered: The “HARMONIA” support measure co-funds transnational R&D projects. The national funding followed up the previous SF- and FP projects, and supplemented the US Air Force-funded project “NOE” to establish a critical mass, strengthen the local IP generation and support the collaboration with leading Italian and American research teams. Research results as of early 2015 include the demonstration of: the plasmonic effect in a metal-oxide eutectic, eutectic materials with anomalous transmission (potentially with negative refraction), strong second harmonic generation, filtering and polarizing properties, bringing the materials closer to an industry-wide implementation. The project budget covers costs of research equipment, consumables, personnel and international mobility.