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Pan European Networks

Science & Technology

IN THE MIX

Innovation and diversity in science are key to providing the energy sources of tomorrow

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DR PAOLO BORTOLOTTI, FROM THALES RESEARCH AND TECHNOLOGY AND DIRECTOR OF THE SpinTronicFactory, SPOKE TO PEN ABOUT HOW THIS INITIATIVE IS MOULDING THE FUTURE OF MAGNETISM

In a spin

The SpinTronicFactory[1] is a European network founded in 2016 with a mission to promote research and innovation in Europe based on spintronic applications. It is based on a legal Memorandum of Understanding involving academic and industrial actors all across Europe. Alongside this, the European Magnetism Association (EMA) aims to promote the development of magnetism and magnetic materials in Europe, and hopes to achieve this by enhancing the visibility and impact of research on fundamental and applied magnetism. EMA acts as an umbrella organisation for activities in magnetism in Europe, giving magnetism a strong voice in the concert of physical sciences.

Pan European Networks asked the SpinTronicFactory's director, Dr Paolo Bortolotti, about the role of the organisation and the importance of better links between academia and industry.

Dr Paolo Bortolotti

Could you begin by outlining the role of the EMA and the SpinTronicFactory more specifically?

In Europe, spintronics and magnetism have traditionally been strong fields from an academic point of view. However, industrial development has been missing. As a way of addressing this fragmentation and of bringing together the academics, industrial partners, research centres and so on in a common voice, the EMA and the SpinTronicFactory were established – the latter aims at building an application-oriented structuring framework that will allow for the integration and governance of spintronic research to be up-scaled.

After its formalisation in May 2016, the first objective of SpinTronicFactory has been to identify some of the major challenges facing the application of spintronics and magnetic materials. During the first Steering Committee (in September 2016) different priority themes were defined, with co-ordinators being allocated to each (though the STF structure will definitely evolve depending on the striking results in the field achieved in the next few years). Four technical pillars related to specific applications have now been identified: magnetic memories, spin-based sensors, radio-frequency and microwave devices, and logic and non-Boolean devices. These are in addition to two transversal axes: advanced materials and fabrication processes, and design and modelling.

The main objectives of the STF project include promoting synergies and collaborations at the EU level (between universities, research facilities and industries), eventually leading to collaborative proposals where some of the most promising spintronic concepts developed in academic laboratories will be promoted towards proof-of-concept, functional demonstrators, and to construct a business-oriented roadmap for spintronics to involve industry in spintronics applications (with related SWOT analysis for each application segment). We also aim to initiate the potential participation of the European spintronics academic and industrial community to a future flagship, to federate activities and co-ordinate actions in Brussels by maintaining a single voice for the spintronic community so as to deliver the same message through all NPCs from all the different participant countries, and to mutualise resources and facilities (nodes of excellence should become innovation hubs in order to facilitate access to spintronic technology) for industry from SMEs to large industrial organisations.

Enhancing the visibility of spintronics is fundamental. Heretofore, we have struggled to find a mention of the technology in many of the European calls for proposals – despite the fact that we are a numerous and strong community. Having an organisation such as the STF will thus help us to develop this and to gain some recognition for the role that spintronics can play in many areas.

The European Magnetism Association (EMA) has similar objectives but for a broader audience. The EMA is aimed at promoting the development of magnetism, magnetic materials and their applications in Europe. To achieve such an objective, the EMA will promote concerted actions between national magnetism societies, universities and research institutions active on magnetism in Europe. The basic idea is to pursue a common policy at European level acting as a whole European community in order to raise significantly the visibility and the impact of research on fundamental and applied magnetism.

Indeed, the EMA acts as an umbrella organisation for several activities on magnetism in Europe: conferences (Joint European Magnetic Symposia: JEMS), schools (European

School of Magnetism: ESM), developments in magnetism-related applications strengthening the links with companies, interaction and co-ordination of activities with other scientific institutions (Condensed Matter Division of the European Physical Society) and the magnetism community worldwide (the IEEE Magnetics Society). STF can be seen as an acting arm of EMA working on a specific sector (spintronics).

Furthermore, the EMA has a crucial role in communication and dissemination: highlighting new and significant results of magnetism research through the EMA's monthly newsletter; advertising job offers in the field of magnetism in both academia and industry through the website (www.magnetism.eu); and as a fast and simple tool to find all interesting conferences and workshops in the field of magnetism. In addition, EMA hosts the website of STF, who clearly profits from EMA visibility.

Another very important role of the EMA is to represent the European magnetism community in European science policy through a lobbying action towards the H2020 European framework programme. There the concerted action with STF is even stronger and the STF community brings up several issues, comments and propositions to H2020 calls, while the EMA supports and pushes forward such initiatives by using their channels.

How would you like to see magnetism and magnetic materials better linked with industry?

Superficial knowledge about magnetism is widespread, and some reservations against (ferro)magnetic materials are common among semiconductor industrial actors. Technical problems with sample yield and reliability still need solutions from fabrication/growth companies and foundries, while protocols and standards need to be defined so as to reassure potential future end users and convince fabrication partners to add magnetic materials to their production lines. Moreover, the cost of moving to magnetic materials is high and, in addition to the acquisition of appropriate tools which are not standard in the semiconductor industry (multi-target thin film deposition systems, ion milling, magnetic annealing, etc.), involves a large effort to develop appropriate processes.

The partners of the SpinTronicFactory network consist of national and regional academic research bodies, universities, and private companies (black: official partners, red: future potential partners)

Thus, the main barrier is to convince more industrial partners to consider magnetism and, more specifically, spintronics. This negative perception is changing today thanks to the spread of the MRAM products. In addition, the growing recognition of spintronics (together with recent large investments in the US and Asia) as one of the most serious candidates for enabling progress beyond the expected limits of complementary metal-oxide semiconductor (CMOS) technology plays an important role. Indeed, this vision is supported worldwide as stated by the ITRS 2.0 roadmap.

In Europe this opinion was reinforced during the European Nanoelectronics Forum 2016 (see: http://www.nanoelectronicsforum.org/forum2016/about/about.php) by Lode Lauwers, vice-president of business development at IMEC, and Francisco Ibanez, deputy head of unit DG Connect at the European Commission. Thus, spintronics can create the basis for a new generation of applications, permitting a renovation of the EU semiconductor industry and opening a new era of growth and market competitiveness. But there is still work to do.

In light of this, the main ambitions of the SpinTronicFactory network are clearly industrial-oriented: to create a European distributed network of expertise and fabrication facilities, available to researchers and industries, so as to rapidly develop new proof of concepts and advance the creation of processes to be included in standard semiconductor technologies; to raise the awareness of European industrial partners on the opportunities provided by this technology; and to promote the creation of new start-ups/SMEs/spin-off companies focusing on spin-based devices.

We have proposed some of those actions in several recent EU proposals, such as the Co-ordination and Support Actions (CSA) in Future Emerging Technologies (FET). EU R&D projects can also help to reach those targets by providing the opportunity for collaboration amongst actors of different sectors, by bringing together complementary expertise and by giving large visibility (communication) to the results of the projects. Dedicated workshops will also help this development. In addition, all actions focusing on the exchange of personnel and training activities would be very useful to integrating expertise and efforts, strengthening transectorial collaboration and human potential on spintronics in Europe,

while the Marie Skłodowska-Curie Actions such as RISE and ITN need to be further exploited.

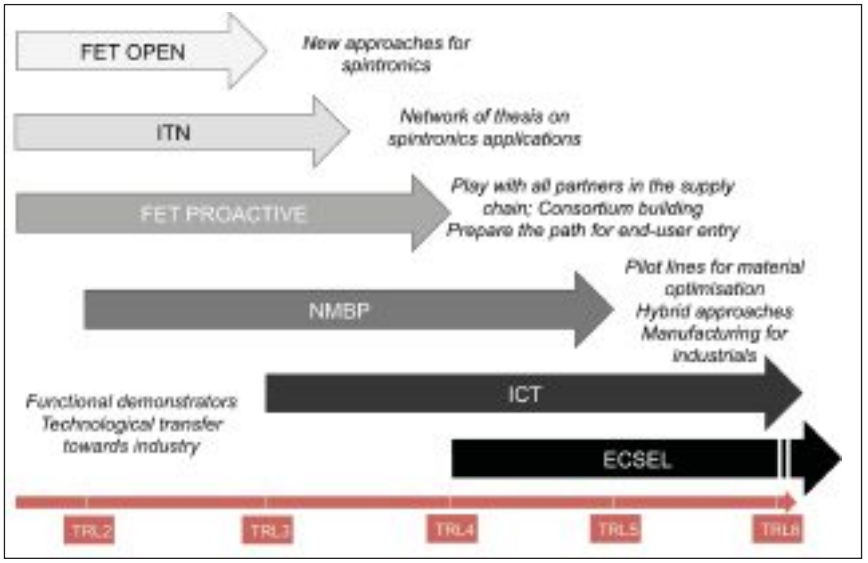
The main barrier is essentially finding a way to make it easier for industrial actors to access this technology, and the innovation hub is thus a way of enhancing visibility.

The objectives of the STF are also vital for EU microelectronics, and this is the right time to propose devices (moving up to higher TRLs) and move towards application. We need to avoid losing European excellence certified by the large number of funded projects, published papers and filed patents. In addition, spintronics could participate in the process to keep fabrication in Europe by providing the right conditions. Therefore, we believe that the activity to structure the spintronic community with the foundation of the STF network is both strategic and timely. However, we are aware that this will only work if the excellent science is linked to a business-oriented roadmap for spintronic applications. In this way, the orientation of new pathways identified by scientists at STF will be connected to the actual needs of market and society. Practically, the SWOT analysis made for specific axes/pillars based on the already identified families of applications (memories, sensors, RF and logic devices) will permit the identification of blocking points and the applicative opportunities. Furthermore, the organisation of workshops and the exchange of staff amongst partners will also help to consolidate the network.

Within our activity, we want to simplify the process 'from ideas to products'. We will first identify a few simple ideas, starting from already running projects when possible, or otherwise preparing specific proposals for such development; then we will bring them up to a functional demonstrator level. Finally, we will largely disseminate these results as an example of success in order to convince industries of the benefit of spintronics.

The involvement of foundries in the network (preliminary contacts have been started with GlobalFoundries Dresden and STMicroelectronics) and partners like IMEC (Leuven, Belgium) or INL (Braga, Portugal) will help access to fabrication (Lab2Fab) for industries and SMEs; the innovation hub mechanism (as proposed in the CSA FET) can also be a good instrument to help this development.

Different TRL levels and corresponding H2020 programmes targeted



In addition, another action we are considering is to prepare the path for resource rationalisation and mutualisation. Our network is large and there are obviously some complementarities but also some overlap. We will therefore conduct a survey of all activities made by the partners focusing on the excellence of outputs. Where possible, we will identify a path for sharing activities (growth, fabrication and characterisation). Eventually, this approach will bring us to the identification of a shared platform/HUB/pilot lines (something along the lines of 'excellence centres for spintronics'). This approach will allow easy access to potentially interested SMEs to the technology, paving the way for larger EU infrastructure projects coupling EU and regional funding.

Our activity also aims at increasing the public awareness of magnetic materials in general and spintronic technology specifically. We will thus use all potential channels to reach a large number of EU citizens and potential new partners.

We also want to help to change the way in which many academics conducting fundamental research simply move on to the next idea at the end of a project, rather than building on their results and moving towards a commercial or industrial application. That may take some time to achieve and will, as with many of the other activities, rely on a much closer co-operative working relationship between academia and industry.

When it comes to R&D&I in spintronics, how would you like to see this better supported in Europe? How would you like to see synergies between different H2020 programmes (FET, NMBP, ICT, ITN, ECSEL)?

Spintronics is somewhat unique in the sense that it encompasses some applications which have reached quite a high TRL and are this close to becoming products, as well as others that are in the development stage, and this is in addition to the fundamental research taking place in the field. As such, we cover all the different parts of the chain and are thus able to

approach many of the different programmes in Horizon 2020: we can approach the ITNs and Marie Skłodowska-Curie Actions for the preparation of students; we can work on FET for novel disruptive technology; we might work in ICT when we have something at TRL 3 and want to bring it to TRL 4 or 5; we can apply to Electronic Components and Systems for European Leadership (ECSEL) for funding when we are developing technologies such as magnetic sensors at a higher TRL.

However, the problem we experience is that while spintronics and magnetic materials fit into any and all of these, those who apply often find themselves redirected to another programme.

The main message is that we want to see calls for Spintronics in the different programmes, and it would be great if future calls have either dedicated topics (spin-based) in the different programmes or are sufficiently general for spintronics to be included within them.

Another important aspect is to link those activities; only a global and co-ordinated action merging all different EU programmes (and the related objectives at different TRL) will permit spintronic applications to develop as we wish and show the discipline's potential and its many societal benefits. Indeed, the STF structure (four technical pillars based on memories, sensors, RF and logic devices) is clearly related to this. We have identified two advanced segments (magnetic memories and sensors) with straightforward economic impact, one partly developed (RF devices) and one still far from the market but with probably the highest potential (magnetic logic). The definition of different business plans and potential challenges will be the core of the SWOT analysis of each pillar.

How do you see the field evolving moving forwards? And how do you predict the role of the EMA and the SpinTronicFactory similarly developing to continue to offer support?

Our objective is to continue in the same direction. We want to get more industrial partners involved in this technology, and in order to do that we need to work on both the roadmap and the innovation hub mechanism, creating excellence nodes where small companies can find a way to develop interesting ideas into functional demonstrators. This will help convince other partners of the potential of the technology and thus help connect research with industry, thereby increasing the number of applications based on spintronics.

We will also continue to promote dissemination and networking via the EMA website (see: http://magnetism.eu/), the ESM schools and the JEMS conferences (the largest and most important conference on magnetism in EU linking applications and devices with fundamental physics), while acting as an umbrella for exchange activities (students, mix engineers from industry and researchers from academics partners, lab visits, and so on).

Connecting with industry (and primarily their stronger engagement) will help to convince more researchers about the opportunity of getting into this path (employability, job offers), and the organisation of several workshops will help to make people aware of the recent and excellent results of novel approaches to spintronics, as well as facilitating the exchange of information about potential applications, the identification of new possible actors and the fostering of renewed support for the development of the spintronic sector according to a jointly developed and approved roadmap.

We will work together with the FORESEEN consortium (see: https://eledia.science.unitn.it/foreseen) on the preparation of a strong proposal for a future flagship on nanoarchitectronics, bridging chip design architecture, nanoscale functionalities, optics, plasmonics and spintronics.

At the STF we will focus on numerous areas, such as attracting industrial partners and moving towards applications and products. However, the excellence of fundamental research in magnetism and spintronics will continue to provide novel, potentially disruptive, approaches to be included on future products and this will also therefore remain a focus for us.

We want, in the end, to foster a virtuous path: the exchange among actors belonging to different nodes of the supply chain (the person in charge of the growth and fabrication, the experimentalist making the characterisation, the engineer dedicated to the circuit design, the person working for the design of a functional proof-of-concept, and obviously the end user) will permit the rapid identification and disentanglement of any bottlenecks, which usually appear in the second stage, and so potentially reduce costs for the innovation activity.

Reference

1 STF: https://spintronicfactory.eu/

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http://magnetism.eu/88-the-spintronicfactory-stf-.htm