Impact Objectives

- Offer a multidisciplinary training in the field of high-tech glasses, ceramics and composites based on effective and proven industry-academia cooperation
- Develop advanced knowledge on glass- and ceramic-based materials
- Develop innovative, cost-competitive and environmentally acceptable materials and processing technologies

CoACHing the next generation of researchers

Materials science holds the key to solving many of our biggest challenges, and in order to harness its full capability it is important that academia and industry maintain a close connection. Below, ***Professors Milena Salvo*** *and* ***Mike Reece*** *and early-career researcher* ***Francesca Ciraldo*** *expain their attempt to develop these bonds as part of a programme that trains early-career researchers how to work with industry*

How did the idea for the CoACH (Advanced glasses, Composites And Ceramics for High growth Industries) project come about?

MS: There is a need for specialists with an interdisciplinary outlook, who are able to combine several engineering disciplines within materials science to support the development of new technologies and products. In the CoACH project, 15 PhD researchers are being trained in creative, independent problem solving under time and resource constraints. This is typical of a scientific and technical working environment in continuous contact with industry, through intersectoral and interdisciplinary secondment and mobility activities between academia and industry.

Why did you choose to focus on supporting postgraduate training in glass, ceramic and composite science and technology?

MS: Because over the past four decades glasses, ceramics and composites have steadily evolved into advanced high-tech materials, and are the basis of some of the most important socioeconomic breakthroughs. Our research group (GLANCE – Glasses, Ceramics and Composites) at the Politecnico di Torino has more than 20 years' experience of such topics.

MR: CoACH also addresses the energy crisis by developing more energy-efficient materials-processing routes. Industry consumes a high proportion of our energy use, and our project involves the development of new energy-harvesting materials (thermoelectrics) to recover waste heat energy in industry and automotive applications.

Just how important is the partnership with industry?

MS: The partnership with industry is fundamental because CoACH aims at training young and highly skilled researchers who are at ease in both industrial and academic environments. This is possible only thanks to the strong and effective industry-academic cooperation and collaboration.

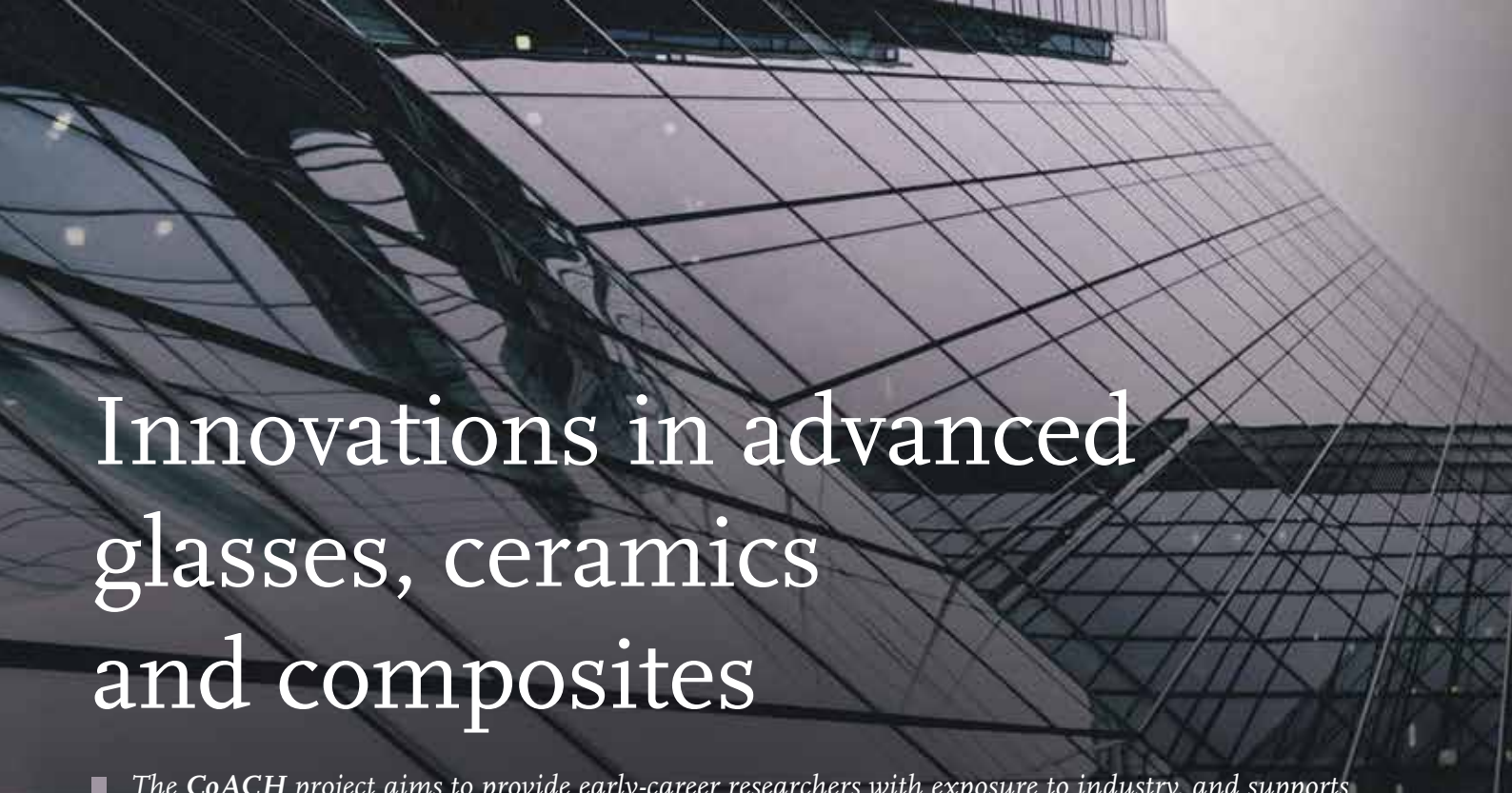
MR: From a company point of view, the non-industrial partners are willing to listen to our needs on timescales that are appropriate to us. A major benefit of this is the opportunity to work with and assess early-stage researchers with the possibility of eventually employing them. We are currently employing one of the researchers trained under GlaCERCo (Glass and CERamic Composites for high technology applications), this project's predecessor.

Ultimately, how will this work translate into practice?

MS: The industry participation of highly qualified companies such as Nanoforce is a clear sign of their commitment to this project and their recognition of the potential benefits of the training activities and research collaborations.

MR: We will see early-stage researchers trained at Nanoforce developing our processes towards the manufacture of commercial products, and researchers moving to other industries to champion new manufacturing processes developed at Nanoforce.

FC: My research is focused on the development of multifunctional coatings for orthopaedic application with bioactive character and antibacterial capability by controlled ion release. This work could lead to the fabrication of new coatings for metallic implants that are able to limit implant-associated infections – one of the main problems during bone surgeries – to avoid biofilm formation and the consequent failure of the implant.



Innovations in advanced glasses, ceramics and composites

*The **CoACH** project aims to provide early-career researchers with exposure to industry, and supports them to produce new and exciting developments in glasses, ceramics and composites for use in various crucial industries*

The development of advanced glasses and ceramics has resulted in some of the most important innovations of the past few decades. Glass optical fibres and amplifiers have played a huge role in the expansion of the internet; bioactive glasses are improving people's lives in the form of biomedical implants; and glass-based coatings have been used in thermal protection systems everywhere from the Space Shuttle to domestic appliances.

All of these achievements have resulted from strong relationships between the researchers who pioneer new materials – or new uses for old materials – and the industrial partners who take those ideas out of the laboratory and into the real world. Such relationships need to be nurtured, so long-term collaborations can form that are mutually beneficial for both researchers and industry representatives.

GlaCERCo was a project previously funded by the European Commission through a Marie Skłodowska-Curie Action, which came to an end in January 2015. Its success, and the internationally recognised scientific outcomes that resulted from it, prompted the formation of a new initiative that built on those successes and continued to push for more cooperation between academia and industry in this crucial sector. And thus, CoACH was born.

THE ADVANCE OF ADVANCED CERAMICS

First and foremost, CoACH, managed by the Politecnico di Torino, focuses on the specific needs expressed by industry, with the intention of maximising the impact of its research outcomes. It consists of five academic partners and 10 industry representatives from across seven different European countries, with 15 PhD researchers currently participating. Continuous contact with the world of industry will enable these early-career scientists to work on some truly meaningful scientific innovations.

The team is highly aware of the potential their project has to make a real difference. 'Because of the continued expansion of their applications, the world market for advanced ceramics (including special glasses and ceramic matrix composites) is projected to exceed US$68 billion by the year 2018,' reveals Professor Milena Salvo, who coordinates the project alongside Professor Monica Ferraris and Dr Cristiana Contardi, all from the Politecnico di Torino. 'The expected outcomes of CoACH activities have strong potential for excellent research and technological developments, and for converting the results into social and economic benefits.'

The initiative is combating gender equality in materials science – a field as plagued by this issue as any other in the world of research. Not only have 40 per cent of the PhD recruits for the project so far been women, but in Salvo, Ferraris and Contardi the project has three women at its helm.

HEALTH, ENERGY AND ENVIRONMENT

The scientific goals of CoACH are based on specific needs that have been expressed by industries, and they can be broadly divided into three categories. All of these categories involve unique research tasks that are now well under way. The first intention is to produce glasses, ceramics and composites that can be used in new healthcare technologies, such as the bioactive, antibacterial coatings for orthopaedic application being developed by PhD student Francesca Ciraldo from the Friedrich-Alexander University of Erlangen-Nuremberg. 'This work could lead to the fabrication of new coatings for metallic implants that are able to limit implant-associated infections, one of the main problems during bone surgeries,' she explains. Such coatings, together with the various glass-based fibres that other CoACH researchers are investigating, have a predicted market value of tens of billions of US dollars, and of course they also possess the capacity to markedly improve health outcomes for many people.

Another key strategic field is energy and ICT industries. The creation of new materials for energy production is helping to improve current methods, such as by developing sensors for the hostile environments found in the petrochemical industry. However, at the same time CoACH researchers are looking for cleaner, more efficient energy strategies: 'Power plants, automotive exhaust and industrial processes all create

'The expected outcomes of CoACH activities have strong potential for excellent research and technological developments, and for converting the results into social and economic benefits'

an enormous amount of unused wasted heat that could be converted to electricity with efficient thermoelectric devices,' explains Salvo. This 'energy scavenging' requires novel glasses and ceramics to be fully realised.

This ties in with the final category of research projects, which involves scientists looking for materials that are both environmentally friendly and low-cost, such as eco-friendly insulation materials produced from waste. The twin goals of achieving better green credentials and maximising efficiency can be seen as the universal drivers in all of these avenues, but they are yielding a diverse set of projects with a diverse set of ambitions.

'Research is dynamic and evolving,' says Professor Mike Reece, Director of Nanoforce Technology Ltd and industry representative on CoACH. 'One of the most difficult challenges is anticipating and organising the secondments for the appropriate partners and timing.' Nevertheless, he thinks there is a good structure in place to allow each of these CoACH projects to respond to developments and react accordingly.

MUTUAL BENEFITS

Salvo and her team are aware of the difficulties that can arise when trying to manage an international team of researchers across a range of different host institutions. 'The challenge consists of creating a win-win cooperation between partners, where each partner understands the constraints of the other,' she explains. While companies are willing to share their expertise and resources, they do require a quick return on technology developments if they are to remain competitive. Conversely, academic institutions are by nature more long-term orientated; however Salvo thinks that by following simple guidelines and procedures these constraints can be overcome: 'In CoACH, this is possible because we are able to base the collaboration on mutual trust, commitment and respect.'

The CoACH team are keen for their participants to engage both with the wider scientific community and the public so as to increase their own knowledge of other subject areas, and the public's understanding of theirs. Besides attending international conferences, CoACH fellows can get involved with CoACH Network Workshops, which are designed to promote knowledge transfer among academic and industrial partners. Moreover, their stall at the annual EU Researchers' Night together with talks at schools and open-access scientific publications means that everyone has the opportunity to learn about this cutting-edge field of materials science.

While it's still early days for CoACH, past successes and the highly capable ensemble of researchers and industry specialists involved in the programme suggest that it could yield some really exciting advances. Aside from the broader benefits that will come to the businesses involved and society as a whole, this project is also about equipping a team of young scientists with skills that will stand them in good stead for careers as high-level, high-impact materials researchers. This in itself is a very worthy goal.

Glass casting, innovative glass optical fibres, insulation materials produced from waste (Politecnico di Torino source) and Spark Plasma Sintering of ceramics and composites (Nanoforce Technology Limited source)

Project Insights

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PARTNERS

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Professor Milena Salvo coordinates the CoACH project with the support of Monica Ferraris and Cristiana Contardi. Salvo is Associate Professor of Materials Science and Technology at the Politecnico di Torino.

Professor Mike Reece is a Director of Nanoforce Technology Ltd, a spin-off from Queen Mary University of London. The company is focused on the development of new processing routes for polymer and ceramic nanocomposites.

Francesca Ciraldo was born in Turin, Italy, in 1989. She studied biomedical engineering at Politecnico di Torino. In 2016 she started her PhD at the Friedrich-Alexander University Erlangen-Nuremberg, in the Institute of Biomaterials.

HR EXCELLENCE IN RESEARCH

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