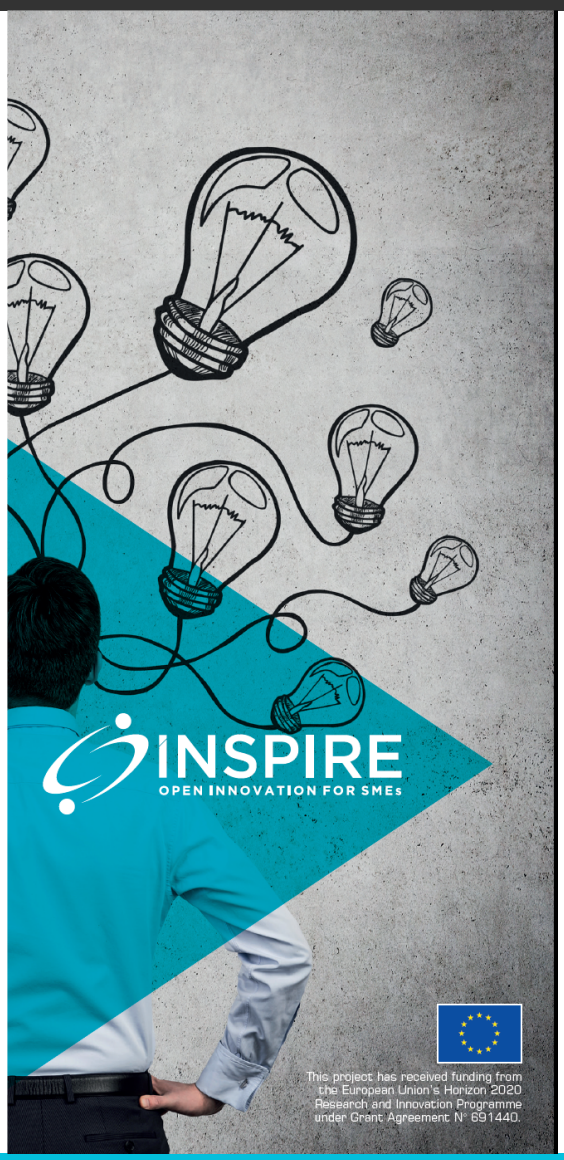

NANOPHOS

Greece, www.nanophos.com

A cross-border and cross-sector collaboration between a Greek SME and a Spanish industrial group led to the development of a new nanobased material to make buildings more energy-efficient

Executive Summary

NanoPhos SA is a Greek nanotechnology company which together with Keraben, a Spanish ceramic tile manufacturer, and with the contribution of the Cool Coverings project consortium, co-developed, tested and validated a new multifunctional nanobased material for the building envelope with improved NIR reflecting, thereby increasing the energy efficiency of renovated as well as new buildings. This successful cooperation enabled the incorporation of the nanobased material in an innovative final product (Cool Tile) for the building industry (to be commercialized by Keraben) as well the launch of a new product range (industrial and retail) by Nanophos.

CASE N°: SE27

SECTOR: NANOTECHNOLOGY

TECH INTENSITY: HIGH-TECH

LIFE CYCLE STAGE: ESTABLISHED

INNOVATION VECTORS: PRODUCT

OI PARTNERS: LARGE CORPORATION

KEYWORDS: Nanotechnology, ceramic tiles, buildings, energy efficiency, paint, cool tiles

NanoPhos
Pioneering Nanotechnology

BACKGROUND

NanoPhos was founded in 2005 with a vision to "Tune the NanoWorld to serve the MacroWorld", thereby bringing to the market nanotechnology innovations which respond to the challenges of everyday life. NanoPhos SA engages in the development, production and sale of chemical and nano- technology products for cleaning, waterproofing, protection and the restoration of surfaces (cement, clay based, marble, granite, wooden surfaces etc.). The company is also active in the paint and coatings industry and offers a series of nanotechnology and microtechnology-based products: ready to use paints, as well as additives for acrylic water based paints which increase their thermal insulating and water repelling properties.

The company, which is based in Lavrio, Greece, sells its products through an extensive distribution network across 25 countries in Europe, the Middle East, Asia and America. Dr. Arabatzis, the managing director of NanoPhos SA, holds a PhD in Chemical Engineering from the National Technological University of Athens (NTUA), an MBA from ALBA Graduate Business School and a BSc in Chemistry from the University of Ioannina.

His major research interests include applied nanotechnology and semiconductors chemistry. He is the co-author of more than 20 scientific articles. His journal contributions have received more than 500 citations from fellow scientists all over the world. Today Dr. Arabatzis is proud to realize his dream by dedicating himself to transferring technology into every day applications.

In 2014 NanoPhos decided to transfer all its experience and successes from the construction market to marine coatings. NanoPhos Marine was established to bring innovative solutions based on the unique properties of nanotechnology to the maritime industry. The NanoPhos Marine product portfolio already includes 25 products focusing on maintenance, cleaning, hull protection, antifouling and fuel saving.

Since December 2015 and following a strategic cooperation agreement between NanoPhos SA and Advanced Polymer Coatings, NanoPhos Marine became the exclusive representative of MarineLine 784 in Greece and Cyprus. MarineLine 784 is the industry-leading cargo tank coating system available for chemical and product carriers, and the only high performance lining that withstands all IMO approved chemical cargoes.

INNOVATION CHALLENGE & MARKET OPPORTUNITIES

Shortly after its foundation, Nanophos managed to establish fully operational internal R&D and production activities. At the same time, however, the company acknowledged the need to be engaged in a constant dialogue with its external environment (research centres, industrial manufacturers, customers, end users) to identify unsolved problems that could be solved potentially with the power of nanotechnology so as to turn them into business opportunities or R&D challenges.

Furthermore, they recognized that joint R&D and pilot testing would help to improve the integration of NanoPhos proprietary technologies into industrial applications, enable access to new markets and provide greater visibility for the company's solutions, both at industrial and retail level. A key vehicle for engaging and advancing joint prototype, testing and demonstration activities has been national and EU funding instruments (FP7, H2020, NSRF, etc.).

The ceramic industry is a traditional and important sector in the EU economy – both in terms of revenue and employment. It is mainly characterized by many small and medium-sized enterprises. At the same time it is a key innovation pioneer and adapter: innovation in the ceramic sector is oriented towards the integration of nanotechnology in new materials and processes to offer novel products with improved functionalities, thus revealing a key target sector for NanoPhos to exploit its IP.

OPEN INNOVATION TRAJECTORY

Concept development

NanoPhos had already developed the SurfaShield® coating technology: a formulation activated simply by the energy of surrounding light (either sunlight or artificial lighting) without the use of high-risk chemicals. Its photocatalytic action enables the decomposition of organic stains and environmental pollutants. The use of this technology protects humans from infectious microbes, eliminates the growth of fungus and minimizes the use of cleaning

waterproof surface, by penetrating deeply into the pores of cement-based substrates. Instead of sealing the pores, nanoparticles “coat them”, assuring that water or other corroding factors are effectively repelled by chemical forces. As nanoparticles do not form polymer chains, Surfashield-treated modified surfaces can last longer, their colour and natural appearance are not modified and they are able to breathe.

Recent work and studies on the subject had already revealed the possibility of increasing drastically the reflection performance of the building envelope using nanotechnologies. NanoPhos and a leading ceramic tile manufacturer – Keraben - were already collaborating, having co-developed and introduced LIFEKER®, an innovative line of self-cleaning and self-sterilizing ceramic tiles. The properties of LIFEKER® tiles were provided by using SurfaShield® coating technology developed by NanoPhos.

NanoPhos was able to exploit its R&D capabilities and unique proprietary technologies by joining the FP7 project Cool Coverings which was led by the Keraben group. The project aimed at developing a novel and cost-effective range of nanotechnology-enabled insulation materials to improve the energy efficiency of the building envelope for retrofits and new constructions.

The technical strategy consisted of developing nanotechnologies that significantly improve the Near Infrared (NIR) reflection capabilities of existing covering materials for roofs and façades while maintaining the traditional colours. New paints, tiles and waterproofing roof membranes could be modified by nanotechnology to achieve high NIR reflectance, with very small aesthetic differences with respect to standard materials.

The project utilized the knowledge and expertise of 3 traditional building material industries, 1 construction company and 8 research & engineering companies to develop, demonstrate and validate in lab and real environment conditions a series of innovative cool covering materials. Those included a new range of coloured paints for façades, a new range of black tiles for façades and a new coloured bitumen-based waterproofing membrane for flat roofs.

Through the Cool Coverings cooperation NanoPhos seized the opportunity to develop a novel near-to-market nanotechnology-enhanced paint and coating with advanced functionalities, which substantially improved NIR (Near Infrared Reflective) properties of the building envelope, based on its SurfaShield® coating technology, and test it in a new application.

The development process, IPR and competition strategy

NanoPhos, in close collaboration with Keraben and the Cool Coatings project consortium, started by investigating the market and industry for reflective coatings, in order to understand the needs to be met. The market research delivered solid and structured evidence about the target areas in insulating technologies where the project approach could provide the most important benefits and impact. Based on these results, the development of nanoxide additives and pigments took place using several different approaches to nanopowder production. The NIR-reflective properties of the new materials were evaluated by the research team members.

These activities paved the way for the new water-based emulsion, which was composed of nanoparticles based on the SurfaShield technology, to be applied in roof tiles, pottery and absorptive cotto tiles. Its innovative formulation was suitably engineered to fit into the pores of clay-based surfaces, providing a continuous hydrophobic layer, as well as providing the binding moiety, responsible for anchoring the nano-particle directly onto the clay surfaces.

The new material was manufactured and incorporated into paint production as a 'cool' pigment by NanoPhos, while Keraben incorporated it in its tile production process (no major interventions were necessary) to develop the “cool” tile.

The prototypes were initially tested in lab conditions, re-creating artificially the effect of the rising and setting sun on standard building substrates. Following the necessary data collection, the prototypes where then installed in a demonstration building to assess their thermal behavior when integrated in a building mass. To do this, several medium scaled buildings were constructed in the area, enabling a comparative analysis under real conditions. The results revealed a 4–7 % decrease in energy use over a 12-month period.

The team also extracted expertise from industrial and research partners in order to obtain a full characterization of the aforementioned materials in all aspects, ranging from risk assessment and performance evaluation (thermal properties, durability, etc.) to an economic and sustainability analysis (market analysis and life-cycle assessment).

NanoPhos owns the technology know-how, while the related co-development activities, incorporation in the tiles and demonstration activities where covered by the project Grant Agreement clauses. Keraben wanted to be free to produce and commercialize the cool tile. At the time the project was finalized, Keraben did not exclude a trademark or a shared patent application, but for the time being they have decided to keep the formula secret. They therefore signed NDA agreements with the key actors (NanoPhos, the research team) and planned the necessary steps and the investment requirements to complete the industrial scale up.

At the time that the new material based on Surfashield technology was applied in roof tiles, pottery and absorptive cotto tiles, no competitors existed. In contrast to traditional sealers that cover the surface with polymerizing additives, this material dresses the pores, the capillaries and the "free" surface of clay-based products with hydrophobic materials. As NanoPhos preferred to focus on B2B agreements for the new material, no specific competition strategy was formulated.

Commercialization and follow-up

Although the current production line needed only a light set up, the industrialization process needed to be fine-tuned. As the owner of the technology know-how, NanoPhos signed an NDA and an exclusive commercial agreement for a limited time-frame with Keraben. When the restrictions were lifted, NanoPhos commercialized the formulation as a series of products for industry and retail.

NanoPhos was able to create and commercialize a whole range of SurfaPore water repellents for building surfaces such as cement and glass tiles, clay, marble, wood and fibrous substrates (SurfaPore C, SurfaShield G) etc. The company's B2B focus drove their marketing efforts via targeted company missions, participation in international exhibitions and affiliation schemes with networks and clusters such as:

- Hellenic Federation of Enterprises - www.sev.org.gr
- Hellenic Association of Chemical Industries - www.haci.gr
- HEMEXPO Hellenic Marine Equipment Manufacturers and Exporters - www.hemexpo.gr
- European Cool Roofs Council - coolroofcouncil.eu

On 4 July 2016 NanoPhos signed four contracts for applications of the SurfaShield products in Beijing China. GCL New Energy Holdings Companies Ltd, Qingdao New Energy Solutions Inc (NESI) and Zhongli Talesun Solar Co., Ltd pledged to implement SurfaShield G in solar cells with a total output of more than 3GW, by the end of 2017. The companies are leaders in their field with GCL being the largest producer of semiconductors for photovoltaic panels worldwide. NESI specializes in rural PV applications and Zhongli Talesun is one of China's largest photovoltaic manufacturers. Dalian Wanda Group, the global giant in accommodation services (hotels, resorts, theme parks, movie theatres and productions) chose SurfaShield C for the rehabilitation and optimization of indoor air quality in their 80 luxury hotels in China.

Keraben recently tested and validated the cool tile in a new reflective wall tile called COOLTILE at the CEVISAMA international trade fair. When installed in a ventilated facade system with 60mm insulation, it reduces the temperature increase of the facade. This served to decrease the heat flow into the building interior, directly resulting in energy savings of up to 30%.

BUSINESS IMPACT

The company applied its highly specialized technical know-how and its IP in the development of a new formulation that has innovative properties, in collaboration with a well-established company in the ceramic market. This was a mutually beneficial collaboration both for the SME and the large company since NanoPhos could develop, test and validate its technology both as an additive to a ceramic product that is to be commercialized by Keraben, a large company that possesses the necessary market reach, as well as commercialize a product range of its own (industrial and retail).

NanoPhos was able to explore further the applications of the technology and create a range of products applicable to new markets (not only ceramic tiles but glass, cement, etc.).

LESSONS LEARNED

By implementing a strategic collaboration with a large and well-established company in the ceramic market, NanoPhos was able to apply its highly specialized technical know-how and its IP in a new product which demonstrated innovative properties and benefits for energy efficiency in buildings.

The validation of the new formulation's capabilities

in ceramic tiles led to the development of a new industrial and retail product for Nanophos. The R&D collaboration triggered the development of both a new wholesale product (paint incorporating the formulation) and the introduction to the market of a new series of products applicable to other surfaces (glass, cement, etc.).

Furthermore, the large corporation was able to fine-tune its production process and test the project's outcome in a new reflective wall tile. This new tile offers a novel solution for renovated as well as new buildings by increasing energy efficiency and improving interior comfort – especially in geographic areas with a hot and sunny climate.

Main lessons learned:

1. Participation opportunities in R&D projects such as FP7 can have substantial impact on research-intensive SMEs through collaboration with different types of actors (SMEs, RTOs, MNEs) active in various industry sectors in the innovation value chain, while facilitating the development, pilot testing and market uptake of research outputs.
2. NanoPhos products and formulations are available for application in a vast number of surfaces and products; however, their incorporation in final products (such as ceramic tiles) required strategic cooperation with the manufacturer of the final product for testing and production.
3. This strategic cooperation had a positive impact on the company driving NanoPhos to explore further applications of the technology to other surfaces, with key innovative and competitive properties, thus opening the door to new markets (not only ceramic tiles, but also glass, cement, etc.). A key milestone in this process was the commercial agreements for technology applications in glass/PVs (China).
4. Through this collaboration, NanoPhos was able to focus on identifying market needs and adapted their proprietary technologies to satisfy them.
5. Among the key success drivers for commercializing NanoPhos' IP were its inclusion in existing industrial applications as well as the absence of major interventions in existing production processes.