IPA 2021

INTELLECTUAL PROPERTY AWARD CEREMONY
THE AWARD DEDICATED TO THE EXCELLENCE OF ITALIAN PUBLIC RESEARCH

28TH OF FEBRUARY TO THE 1ST OF MARCH 2022
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RAPID PURIFICATION OF PHYCOBILIPROTEINS
TECHNOLOGY READINESS LEVEL (TRL): 5/6

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Rosaria Lauceri
Patent number 102018000006062
License INTERNATIONAL

CHALLENGE

Phycobiliproteins are water-soluble non-toxic pigment-proteins produced by some microalgae, that have strong antioxidant activity as well as anticancer, anti-inflammatory and immunomodulatory properties, with applications in biomedicine, pharmaceutics, cosmetics and foods. Currently, despite the numerous purification methods available on a laboratory scale, large scale production of phycobiliproteins remains problematic. The complexity of the processes and the high costs involved in obtaining middle-high purity grade phycobiliprotein, constrain its applications and market availability.

TECHNOLOGY

Method to purify phycobiliproteins, extracted from cyanobacteria and algae with aqueous solutions, applying Membrane Chromatography (MC). The MC process is carried out by using microfiltration PVDF membranes, inducing selective and reversible protein-membrane interactions through ammonium sulphate. By changing the ammonium sulphate concentration, it is possible to selectively separate the various phycobiliprotein fractions present in the biomass extract and, applying the appropriate number of MC steps, to achieve the desired purity, up to the analytical grade (P≥4). Analytical grade phycocyanin (extracted from *Arthrospira platensis*, i.e., Spirulina) and B-phycoerythrin (extracted from *Porphyridium cruentum*) have been obtained applying this method.

DEVELOPMENT STATUS

Scale-up of the protected technology in collaboration with the company Plastica Alfa SpA to demonstrate the effectiveness of the technology in an industrial environment. Currently, CNR and Plastica Alfa are partners within a Proof-of-Concept Project, for the realization of an industrial prototype based on this CNR technology to produce high purity phycocyanin for commercial applications.

COMMERCIAL OPPORTUNITY

he technology is based on a simple process and requires low initial investment and service costs, allowing for a very competitive value-for-money ratio. The mild conditions of the process preserve the pigment-protein structure, ensuring high quality product. The method can be tuned in order to obtain products having various grade of purity (maximizing the yield), that meet the needs of various market sectors, from the food/nutraceutical to the biomedical one.

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ZENIT SMART POLYCRYSTALS: MATERIALS FOR INNOVATIVE LASERS
TECHNOLOGY READINESS LEVEL (TRL): 4

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Jan Hostaša
Patent number 102020000005998
License INTERNATIONAL

CHALLENGE
Polycrystalline transparent materials where the dopant concentration is graduated and controlled for light guiding or thermal management, are very promising materials for many laser applications. The performance of the currently used uniformly doped single crystals is limited by the thermal load generated in the active medium during laser emission. To overcome these limits, diffusion bonding is used to join together carefully cut and polished materials, mostly single crystals, with a different dopant or doping level. As an alternative, transparent ceramics with compositional gradients may be produced by assembling multiple layers or parts during shaping. Unfortunately, these fabrication techniques do not allow a precise control of the doping structure of the components. For these reasons, the commercial exploitation of laser gain media is slowed by the lack of an industrial-friendly fabrication process.

TECHNOLOGY
A process to obtain transparent polycrystalline components with complex shapes and compositions that overcome the limits of the components currently used as laser gain media, scintillators and in lighting. It relates to an additive manufacturing process, viz. stereolithography, for the production, starting from a CAD drawing, of ceramic-based transparent materials with a variable 3-dimensional (3D) composition and complex shapes, providing complete control of the shape and of the composition. The invention also relates to all the processing steps that are necessary to obtain the final components, i.e., selection of the starting powders and organic additives mutually compatible and suitable for stereolithography, the de-binding and the sintering treatments The minimum dimensions of the components obtainable with the invention are 0.5 x 0.5 x 0.5 mm, and the maximum dimensions are 100 x 100 x 9 mm.

DEVELOPMENT STATUS
In September 2021, the research team founded a spin-off company, Zenit Smart Polycrystals. Recently, Zenit received an investment for a Proof-of-Concept phase, focused on R&D activities and production of laser gain media prototypes for the solid-state laser market and on the identification of potential. The research team is interested in finding suitable partners for developing lasers used in the medical (surgery lasers) and industrial sector (laser welding and machining), and components for lighting (converters for laser headlights for the automotive sector) and for scintillating detectors.

COMMERCIAL OPPORTUNITY
Solid-state laser market, where the high manufacturing costs, the performance losses due to thermal gradients and parasitic emissions, and the excessive weight and volume of the equipment are a hindrance to development. With this invention, new laser gain media can be produced to replace conventional single crystals, allowing a drastic reduction of the performance losses, thus increasing the laser efficiency. The specific products will be for example YAG polycrystals formed by different chemical compositions both to be used in current devices via a seamless substitution as well as for innovative custom-made solutions.

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NEAR-ZERO EROSION, ULTRA HIGH TEMPERATURE CERAMIC COMPOSITE

TECHNOLOGY READINESS LEVEL (TRL): 5/6

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Luca Zoli
Patent number 102016000008310
License INTERNATIONAL

CHALLENGE

The aerospace and hyper speed transportation markets rely on ceramic matrix composites based on silicon carbide and carbon; excellent structural materials for high temperature capable of operating without a cryogenic cooling system (e.g., metals). However, silicon carbide-based materials are limited to temperatures below 1400°C, whilst graphite-based composites withstand 3000°C but have limited durability, and are disposable for rapid ablation in oxidizing environments.
All these composites are characterized by an extremely time-consuming production processes (machine time 1-6 months) and costs (>> 500 EUR/Kg). The manufacturing processes of the current materials foresee a further treatment such as coating. Currently there is a rush to replace the production processes to produce materials by greener and time saving processes with attention to cost-effective to replace in particular carbon_carbon with high durable materials.

TECHNOLOGY

The patent concerns the design and manufacture of near-zero ablation/erosion fibre-reinforced ultra-high temperature ceramic matrix composite (UHTCMC) materials with the ability to withstand sudden temperature changes even above 1800°C, in particularly aggressive environments from a chemical and mechanical point of views, resulting therefore reusable or with a durability superior to currently used materials. The process, allows for the fabrication of materials with high added value in a short time, with regard to the eco-sustainable aspect of the process. From a technical point of view, the process is mainly based on 1) impregnation of carbon fibre fabrics with a mixture of ultra-high temperature ceramic phases powders and 2) consolidation by sintering.

DEVELOPMENT STATUS

A CNR spin-off (www.k3rx.com) is currently working on the production of batches or semi-finished products tailored for the R&D sectors of aerospace companies. At this stage, the company will achieve low earnings, whilst collecting commercial and technical information. Subsequently, the spin-off will obtain necessary certifications and new financial and marketing plans are going to be developed while revenue is expected from the development and manufacturing of components. Finally, based on the trends of the previous activities, the generation of customized offers of components for the actual production of potential customers and possibly the generation of standardized offers is assumed.

COMMERCIAL OPPORTUNITY

Fabrication of components of thermal protection systems and rocket motors for hypersonic vehicles such as leading edges, nosecones, tiles rocket nozzles and chamber inserts. Possibility of using implementing the patent for the production of discs for braking systems of high-speed trains or of civil/freight aircraft.
The intrinsic characteristics of UHTCMC materials can also lead to the development of components not known to date. In particular, every field in which the maintenance/ replacement of current components is more expensive than moving to new, more performing, materials.

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LOW-POWER MAGNETOMETER FOR IMPROVED SENSORS INTEGRATION IN FUTURE VEHICLES
TECHNOLOGY READINESS LEVEL (TRL): 3

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Federico Maspero
Patent number 102020000007969 - PCT: WO2021209891 A1
License INTERNATIONAL

CHALLENGE
Electric cars, autonomous driving and drones will have a key role in future mobility. Conventionally, Lidar, magnetic sensors and inertial sensors are used for electronic stability of the vehicle. Magnetic field sensors and inertial sensors are based on two different technologies. The first uses magneto-resistive technology, in which the value of field-depended resistor is measured, while the second is based on micro-electro-mechanical-systems (MEMS) with capacitive actuation and detection. Here we propose, a MEMS magnetometer to ease the integration between magnetic sensors and inertial sensors, offering both high performance (e.g., sensors alignment), with low power consumption and possibility of integration into existing processes.

TECHNOLOGY
The MEMS magnetometer is composed of three main elements: a MEMS resonator, a permanent magnet and a pair of magnetic flux concentrators (MFCs). The permanent magnet is patterned on the moving element and placed in proximity of the MFCs. The flux concentrators convey the external magnetic field and produce a magnetic field gradient in the region of the permanent magnets. The force generated by the interaction of the magnetic field gradient and the magnets induces a frequency shift of the MEMS resonator. Such variation can be detected by the electronics coupled to the sensor and used to compute the incoming magnetic field. The MEMS magnetometer can be fabricated with standard industrial MEMS processes and be integrated with existing inertial sensors (accelerometers, gyroscopes), enabling a fully-MEMS inertial measurement unit, reducing the integration problem of MEMS sensor with magnetic sensor and obtaining a compact and high-resolution sensor with low power consumption.

DEVELOPMENT STATUS
The patent has been extended internationally, whilst, in the next 6 month the device will be fully characterized and further bench-testing conducted. Within one year, the team foresees the on-boarding of an industrial partner, for prototype production to meet industrial standards, for further validation, and subsequent commercialization.

COMMERCIAL OPPORTUNITY
Licensing the technology to a company operating in the MEMS and microelectronic business. This technology would bring the most benefits upon its integration within drones, as these require low power consumption of the mounted electronics in order to extend the flight range and make large use of inertial measurement units for electronic stability control. The possibility of single-chip fully-MEMS IMUs can offer a reduction of cost and size together with an improvement of alignments between sensors.

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