AGENCE NATIONALE DE LA RECHERCHE

ANR

# Presentation of the funded projects in 2010 for the Programme « Blanc international SIMI10 »





AFAQ ISO 9001

« Blanc International SIMI 10 » Programme

**YEAR 2010**

| **Project title** | GoldenEye – Preclinical investigation of gold nanoparticles for plasmonic photothermal therapy of renal cell carcinoma |
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| **Abstract** | The aim of this project is to propose an innovative approach based on specifically designed gold nanoprobes for imaging and hyperthermia in Renal Cell Carcinoma (RCC). These nanoparticles will serve both as powerful contrast agent for enhanced photoacoustic imaging and as efficient heat sources for local tumor thermal destruction. The microvessel network of malignant tumors offers a preferential area of distribution and enhanced uptake for nanoparticles, and RCC is particularly well suited since it is one of the most highly vascularised human tumor with a high metastatic potential through blood vessels. The originality and ambition of the project is to use the unique optical properties of gold nanorods and nanoshells for a fine in vivo characterization of the microvessel network of malignant tumors, and for the local photothermia of targeted tumor areas. This is a rupture with already clinically validated methods of in vivo tumor imaging which are based on the volume assessment of the tumoral mass, or on its capacity to fix markers of the tumor cell metabolism. Besides, a major problem for the in vivo human cancer imaging is the lack of precise assessment of the tumoral microvessel network. This assessment is particularly important for the follow up of cancers treated with new antiangiogenic drugs. We propose to fill these gaps by pursing the following aims: A. investigate the efficiency of nanoparticle (NP) retention for NP enabled plasmonic photothermal therapy in a unique xenograft mouse model; B. develop the techniques of interstitial fluence rate/autofluorescence measurements and photoacoustic imaging to quickly and directly monitor the outcome of plasmonic photothermal therapy; C. demonstrate that these two techniques are complementary for the monitoring of plasmonic photothermal therapy in terms of optical contrast, penetration depth and spatial resolution. The proposed research will yield several outcomes that may have significant clinical and/or scientific impacts: A. Nanotechnology enabled plasmonic photothermal therapy will provide a minimally invasive alternative to current cancer therapies for treating RCC. B. The optical techniques developed in this project will be extremely useful for the monitoring of cancer therapy and noninvasive characterization of microvasculature in deep tissue in both clinical applications and biological research. C. The xenograft mice model for RCC will provide an alternative of human RCC for medical research to ameliorate the problem |

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| | of insufficient human tissues for medical research. The project uses highly specialized technologies and methodologies already developed and mastered by the physicists, physicians and biologists partners of the consortium: plasmonic properties of the gold nanoprobes, in vivo optical tomography techniques, xenografts of human tumors, assessment of therapy-induced tissue damage and plasmonic hyperthermia. The complementarity of the french and singapore partners is essential for the success of the project. Singapore team will be in charge of the plasmonic photothermal therapy and autofluorescence sensing, the french partners will develop nanoplasmonic enhanced photoacoustic imaging and preclinical mouse model of the RCC. For the final task of the project, all the partners will work together jointly in a unique place at the Hospital Saint Louis to investigate the effects of plasmonic photoheating using non invasive photoacoustic imaging on the preclinical mouse model. |
| **Partners** | UMR 7587 – Institut Langevin<br>U728 – Laboratoire de Pathologie<br>Division of Bioengineering (Singapore) |
| **Coordinator** | Emmanuel FORT - UMR 7587<br>emmanuel.fort@espci.fr |
| **ANR funding** | 240 223 € |
| **Starting date and duration** | - 36 months |
| **Reference** | ANR-10-INTB-1003 |
| **Cluster label** | |

| Project title | NeuroDiam – Fluorescent diamond nanoparticle: an innovating probe to study macromolecular organization and trafficking in neurons |
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| Abstract | The NEURODIAM project aims at studying macromolecular organization and trafficking in neurons using a new fluorescent nanoparticle probe relying on functionalized fluorescent nanodiamond (fND), which have the remarkable properties of a perfectly stable fluorescence and an optically detected electron-spin resonance at room temperature. Four teams are involved in this multidisciplinary project: * Two Taiwanese teams: - Huan-Cheng CHANG's team at the Institute of Atomic and Molecular Science (IAMS), belonging to Academia Sinica, Taipei (Taiwan) - Chih-Che (Eric) WU's team from Department of Applied Chemistry at the National Chi Nan University (NCNU), in Nantou (Taiwan) * Two French teams - François TREUSSART's team at Laboratoire de Photonique Quantique et Moléculaire (UMR CNRS 8537) in ENS Cachan - Michel SIMONNEAU's team from Centre de Psychiatrie et Neurosciences (INSERM U894, & Univ. Paris Descartes), in Paris. The complementary expertises of these teams are in nanobiotechnology, surface functionalization applied to nanosciences, nanophotonics, molecular genetics applied to neurosciences, respectively. The project uses a unique combination of novel high-resolution fluorescent microscopies and of the fluorescent nanodiamonds functionnalized to interact with genetically engineered neuronal proteins in order to gain novel information on neuronal functions. We selected to study neuronal functions that are known to be deregulated in various neuropsychiatric and neurodegeneratives diseases, having a high prevalence and being important societal burdens. The project aims to study three neuronal functions that are known to be deregulated in psychiatric and neurodegenerative disorders: - dendritic trafficking - dendritic spine morphology changes linked to synaptic plasticity - retrograde axonal trafficking. Dendritic trafficking and dendritic spine plasticity are modified in psychiatric diseases. Dendritic spine plasticity is abnormal in early steps of Alzheimer disease. Retrograde axonal trafficking was also found abnormal in animal models of Alzheimer and Down’s disease. A significant part of the project, participating to its originality, will also be devoted to the development and optimization of the super-resolution imaging techniques. In this project we will develop simultaneously a conventional STED microscopes and a complementary high-resolution imaging technique to |

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| | STED, which can distinguish individual fNDs, relying on the other remarkable properties of NV-, which is to possess an electron spin resonance (ESR), in the microwave domain (2.87 GHz) that can be optically detected. This property allows optical detection of Magnetic Resonance of NV- center (NV-MRI) in a magnetic field gradient. Two super-resolution imaging, STED and NV-MRI will be developed in parallel with performance allowing the analysis of the macromolecular organization inside dendritic spines. The original key point of this project is its multidisciplinarity. It combines: - state-of-the-art methodologies in novel microscopies (STED and optically detected magnetic resonance) - nanodiamonds as fluorescent nanoparticles - functionalization using biotin - genetical engineering of proteins of interest in order to use the tight binding of biotin to streptavidin. |
| **Partners** | Laboratoire de Photonique Quantique et Moléculaire<br>Centre de Psychiatrie et Neurosciences<br>Institute of Atomic and Molecular Science (Taiwan)<br>National Chi Nan University (Taiwan) |
| **Coordinator** | François TREUSSART – LPQM, UMR8537 CNRS & ENS Cachan<br>francois.treussart@ens-cachan.fr |
| **ANR funding** | 202 800 € |
| **Starting date and duration** | 15 février 2011- 36 months |
| **Reference** | ANR-10-INTB-1002 |
| **Cluster label** | |

| Project title | UPSTIN – Ultra-low power spin transistor based on InAs nanowires |
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| Abstract | Objective of the present proposal is to establish the basis of ultra-low-power circuit operation by achieving steep slope of gate voltage for on/off switching through the successful Datta-Das type spin transistor of semiconductor nanowires. Low voltage operation of conventional semiconductor electron device (CMOS integrated circuit) is limited by Boltzmann factor. As a result, modern integrated circuits is confronted with the power consumption problem by the continuing integration level of million gates and operation speed exceeding a few Ghz. It is anticipated that extremely low voltage operation is feasible if spin degree of freedom is used in ferromagnet/semiconductor hybrid structure as will be explained extensively in the description of research projects |
| Partners | Laboratoire de Photonique et Nanostructures<br>Research Center for Integrated Quantum Electronics - Hokkaido University (Japan) |
| Coordinator | Jean-Christophe HARMAND - LPN-CNRS<br>jean-christophe.harmand@lpn.cnrs.fr |
| ANR funding | 154 319,36 € |
| Starting date and duration | 28/12/10 - 36 months |
| Reference | ANR-10-INTB-1001 |
| Cluster label | |