

Post-doctoral position 2016

Laser-induced self-organization of metallic nanoparticles: study of the physico-chemical mechanisms and parameters to generate original effects on plastic substrates

Host laboratory	Laboratoire Hubert Curien (LabHC) , UMR 5516 CNRS Université Jean Monnet, 18 Rue du Professeur Benoît Lauras, 42000 Saint-Etienne, France
Supervisors	Nathalie Destouches (LabHC)
Start	January 4 th , 2016
Duration	2 years
Funding	The post-doc is funded by an industrial partner and the monthly gross salary is 3050 € per month
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This project directly addresses one of the major societal challenges of the 21st century: the quest of enhanced security policies and technologies which include better methods of personal identification. And today's market offer for ID documents is not satisfactory and not innovative enough with old static security features inherited from banknotes and paper security.

Ultimately, the objective is to develop a laser process to engrave designs, with original visual effects, in embedded layers of plastic cards for more durable security features while in circulation and forgery-proof.

This process is based on the laser-induced self-organized growth of metallic nanoparticles (MNPs), effect recently highlighted and investigated by LabHC on glass substrates. In this process, the substrate is first functionalized with a photosensitive Ag:TiO₂ film, then exposed to a single scanning laser beam which implements self-organization (Fig. 1). A lot of experiments with continuous wave visible laser led to a wide range of colors as well as to singular dichroic effects (Fig. 2). However, present laser processes result in a high temperature rise in the film which prevents a direct transposition to plastic substrates.

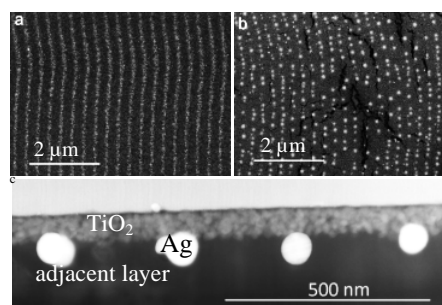


Fig. 1: Laser-induced self-organized MNPs. a-b) SEM top views, c) STEM cross-section

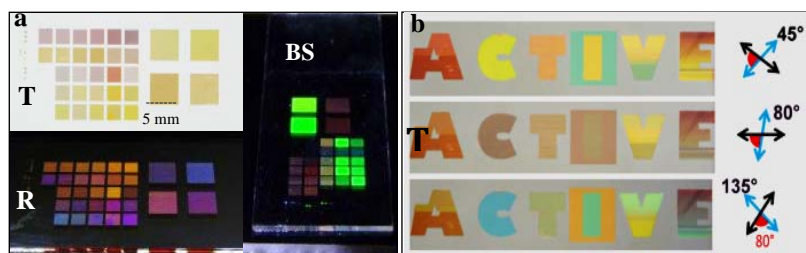


Fig. 2: Few examples of visual effects. Each pattern is characterized by a set of colors, whose number can be large, by varying the observation conditions, e.g.: a) transmission (T), specular reflection (R), backscattering (BS), or b) the polarization for a fixed geometry (T).

From a fundamental point of view, this project is a major opportunity to better understand the laser-induced self-organization mechanisms that occur in the volume of multilayer and nanocomposite materials. This topic remains largely unexplored and could lead to many other applications by providing an innovative cost-effective and rapid nano-structuring process to replace lithography techniques. On the other hand, considering potential applications, project's results could be used to develop a new standard security feature and orientate the market paving the way to a new holder identification approach.

Various experimental works and simulations will be conducted in parallel. Some studies or trials will be carried out in collaboration with international partners such as an Indonesian card manufacturer with potential travels on site of various project partners. The candidate should speak and write English fluently, should have good skills in sol-gel chemistry and knowledge in laser-matter interaction, plasmonics, multiscale characterization techniques physical chemistry of surfaces. He or she should have skills for experimentation and for the management of multidisciplinary research. We expect candidates with very good publications, experience in international conferences, an open mind and a strong motivation. Given the multidisciplinary nature of the subject, it is not expected that the candidate has expertise in all fields of the project, but he/she should be able to adapt.

Interested candidates are invited to send a CV with a brief cover letter and available transcripts to nathalie.destouches@univ-st-etienne.fr before November 30, 2015.

The industrial partner has got significant experience in the e-Documents industries, delivers complex end-to-end and modular solutions to both public and private sectors, complying with the most stringent international standards in several countries worldwide. The company has got in-house expertise in areas such as passport and card materials and physical security features. Operations are managed from three offices worldwide in Europe and Asia areas.