PhD position

Vanadium Dioxide-Based Films for Randomizing Photonic Emission and Absorption of Integrated Circuits

Funding: ANR project VO2Random

Period: October 2024 – September 2027

Host: Laboratoire Hubert Curien, UMR CNRS 5516, Université Jean Monnet (Saint-Étienne, France)

PhD School: École Doctorale ED SIS 488: Science, Ingénierie, Santé

Project:

The goal is to develop a smart coating that will prevent exploiting the photonic emission and absorption from integrated circuits, effectively limiting the use of optical techniques to reverse-engineer microchips or access the stored secret data.

The semi-conductor material of transistors in an electronic circuit emits and absorbs near-infrared radiation that can be used to obtain (passive attack) or change (active attack) the state of the circuit and access stored data or its exact configuration. A thermochromic coating based on vanadium dioxide (VO_2) will be developed to alter the photonic properties of the chip owing to heat variations during the attack. VO_2 is a well-known thermochromic material turning from a transparent dielectric to an opaque metal when heated above its phase transition at 68°C. VO_2 films can be synthesized using pulsed-laser deposition with thermal annealing, and will be used as a very thin and hard-to-detect coating on electronic chips. In particular, its critical temperature can be adapted to any range of circuit operating temperature by varying the synthesis parameters, doping, post-treatment or inducing strain. The quality of the thin films will also be enhanced through the use of ultrashort-pulsed lasers (femto- and picosecond) in “burst mode” (GHz and MHz repetition rate).

Tailoring VO_2 optical and thermal properties will lead to new applications not only in cybersecurity, the main target of the project, but also in the domains of infrared imaging, thermo-switchable optical, IR and RF devices, etc.

Environment:

The PhD student will be part of both the ‘Laser-Matter Interaction’ and the ‘Secure Embedded Systems & Hardware Architectures’ teams at the Laboratoire Hubert Curien (UMR CNRS 5516). She/He will have access to all the systems allowing for the synthesis and characterization of vanadium-based materials: femtosecond lasers and vacuum chambers for pulsed-laser deposition, Rapid Thermal Annealing ovens, Scanning and Transmission electron microscopy (SEM, TEM) coupled with Energy Dispersive Spectroscopy (EDX), Atomic Force Microscopy (AFM), Raman microscopy, ellipsometry and setups for probing the attack on electronic circuits. She/He can expect to be formally trained and acquire experience on most of these devices.

This PhD is part of the ANR funded **VO2Random** project, headed by F. Bourquard in collaboration with the Institut Jean Lamour (IJL) in Nancy (France). The funding will allow for exchanges between the different partners, aimed at exploring different deposition methods and characterizations. It will also secure access to all equipment, and cover participation to international conferences.

Requirements:

The ideal candidate should have a strong background in physics, and hold a master degree (or equivalent) in photonics and/or material science. Experience with electronics and knowledge in cybersecurity is not mandatory but will be appreciated.

She/He should have good organization skills and be able to manage the synthesis and characterization of many samples using various techniques. A good scientific culture and ability to communicate scientific results will be essential to facilitate interaction among the interdisciplinary teams engaged in this project. Skills to effectively translate complex findings for the broader public will also be necessary.

How to apply:

Interested applicants are invited to send their CV, **before the 30/04/2024**, to:

Florent Bourquard, Associate Professor: florent.bourquard@univ-st-etienne.fr

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