Laser synthesis of hyperdoped Si and $CoSi_2$ thin films for superconducting quantum devices

P.Dumas, F. Nemouchi, S. Kerdiles, M. Opprecht, P. Gergaud, G. Freychet *(CEA-LETI / Grenoble)*

Francois Lefloch, F. Gustavo *(CEA-IRIG / Grenoble)*

J. Labar, B. Pecz Budapest *(EK-MFA / Budapest)*

Y. Yao, S.-L Zhang, Z. Zhang, T. Kubart *(Uppsala University)*

In the race towards building a quantum computer, there is a deep interest in fabricating devices based on the robust and scalable silicon technology. In this context, our research team aims at fabricating silicon Josephson Field Effect Transistors (JoFET) which have the particularity of featuring superconducting materials in place of source/drain contacts. Provided a sufficiently high transparency between the superconducting contacts and the semiconducting channel, a gate-tunable non-dissipative current can flow through the device.

Among superconducting materials compatible with large-scale integration, boron-hyperdoped silicon (Si:B) and cobalt disilicide ($CoSi_2$) appear to be the most suitable in term of transparency. Here, we present a comprehensive material study on their fabrication and integration issues in a Fully-Depleted Silicon-On-Insulator technology. A focus is done on Nanosecond-Pulsed-Laser-Annealing (NPLA) as it plays a key role in hyperdoping silicon with boron (Si:B) and offers an alternative process for improving $CoSi_2$ morphology and superconductivity. The effect of NPLA on the distribution of dopants, the development of strains and the morphology of thin films is highlighted by X-Ray diffraction, Transmission Electron Microscopy and Atom Probe Tomography. Finally, we present some preliminary findings regarding the electrical characteristics of superconducting Si-based transistors.