How the liquid metal alloy sources allow a versatile use for the ion beam nanofabrication

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The Focused Ion Beam (FIB) has emerged over the past decade as an exceptionally powerful tool that has taken its place among the suite of other instruments in Material Science. Whether configured as a single beam or dual-beam microscope, this instrument can be used for a variety of purposes in both ranges of materials characterization and manipulation technics that include ion microprobe, secondary ion mass spectroscopy, ion microscopy, lithography, microfabrication, ion beam etching, ion implantation or ion beam deposition.
Combined with a Wien Filter capable of separating the different species of a Liquid Metal Alloy Ion Source (LMAIS), such a filtered FIB (ExB FIB) enables the use of a vast majority of ion species [1] and increases, even more, the potential applications.
This Wien filter consists of a uniform electric and orthogonal magnetic fields and an aperture to select the desired velocity.

With more than 30 years of experience and leadership in the charged optic's particles field, ORSAY PHYSICS is the world leader in customized focused ion and electron beam technologies. In this presentation, we will give two examples of possible applications with two types of ion sources.

1. The first application is based on a Gold-Germanium (AuGe) alloy ion source. Ge or Au ions beams are dedicated to the nanopatterning of silicon-germanium on insulator substrates (SGOI). The purpose is to form Ge and Au nanocrystals with specific and innovative electronic properties by the combination of FIB ion etching processes followed by the dewetting process in the Rapid Thermal Oxidation (RTO). Other applications such as photonic crystals will also be presented.
2. The second application is employing either the AuGe or Auand silicon (AuSi) sources for the implantation of diamond and silicon substrates. The aim here is to create color centers (SiV or GeV) in diamond or in ultra-thin SOI (Silicon on Insulator) for quantum technologies and sensing with Si ions. The advantage of FIB nanolithography is its capability to locally implant Ge ions in diamond to fabricate single-photon sources like germanium-vacancy (GeV) single color center

[1] L. Bischoff, P. Mazarov, L. Bruchhaus and J. Gierak, Appl. Phys. Rev., 3 (2016), 021101.

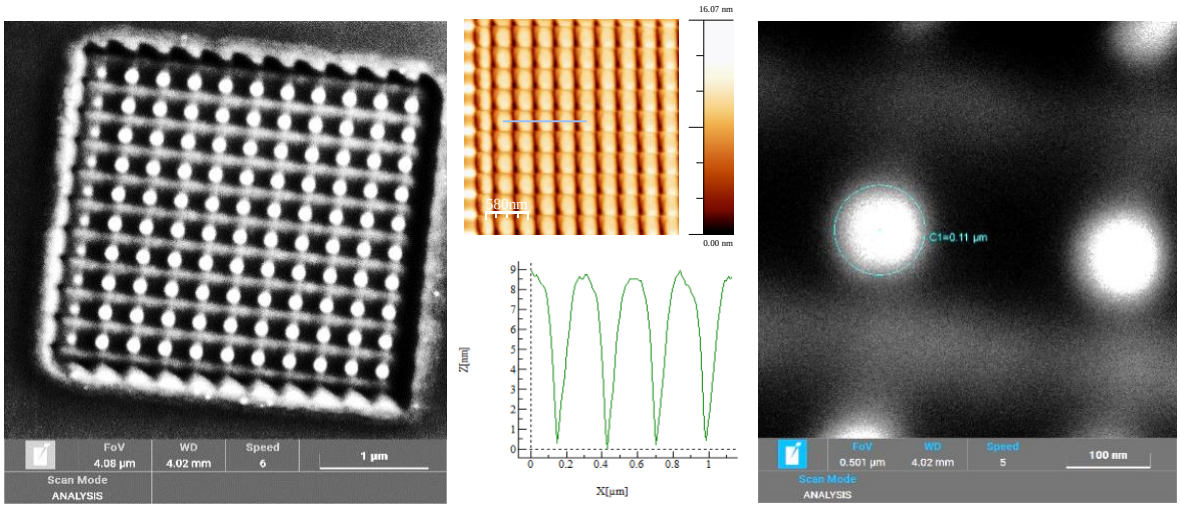

Figure 1: High-resolution SEM of Ge islands obtained by a two step process: etching with $74Ge^{2+}$ under 30 keV in SGOI followed by oxidation at 750 °C for 6 hours in the RTO