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Li-containing liquid metal alloy ion sources for focused-ion beam instrumentation

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Focused Ion Beams (FIB) gain an increasing interest in the field of nanotechnology particular for prototyping of microelectronic devices, patterning of 2D materials, high resolution imaging or high resolution ion lithography[1]. Concerning ion beam resolution and minimization of unwanted damage, light ions like He or Li are preferred candidates. Liquid metal alloy ion sources (LMAIS) with a life time of more than 1000 µAh on the basis of $Ga_{35}Bi_{60}Li_5$ and $Sn_{95}Li_5$ alloys were developed, characterized and finally applied in a commercial mass-separated VELION FIB-SEM system (Raith GmbH). The resolution for imaging and also for the formation of nanostructures using a thin gold film was determined.

In the case of Li ions from the mass separated FIB a lateral resolution of 5.6 nm could be obtained in first experiments[2] and the sputter yield was determined to 0.4 for 35 keV Li ions on Au. For reference, the helium ion microscope (HIM) has a lateral resolution of about 0.5 nm and 1.8 nm, for He and Ne respectively, He has a sputter yield of 0.1[3]. For sub-10 nm focused ion beam nanofabrication and microscopy, the GaBiLi-FIB or the SnLi-FIB could therefore be considered alternatives to the HIM with the benefit of providing additional ion species in a mass separated FIB without changing the ion source.

[1] L. Bischoff et al. Appl. Phys. Rev. **3**, 021 101 (2016).
[2] W. Pilz et al. J. Vac. Sci. Technol. B A-18-399 (submitted, 2018).
[3] G. Hlawacek et al. J. Vac. Sci. Technol. B **32**, 020 801 (2014).