Ultra-smooth lithium niobate micro-resonators by surface tension reshaping

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Abstract: Thermal treatment of micro-structured lithium niobate substrates at temperatures close to, but below the melting point, allows surface tension to reshape a preferentially melted surface zone [1] of the crystal to form ultra-smooth single crystal toroidal or spherical structures. Such structures, an example of which is shown in figure 1, are suitable for the fabrication of photonic micro-resonators with low scattering loss. The thermally treated material maintains its single crystal nature after the thermal treatment because the bulk remains solid throughout the process acting as seed during the re-crystallization process which takes place during the cooling stage. The single crystal nature of the re-shaped material has been verified by piezoresponse force microscopy, Raman spectroscopy and chemical etching. The inherent properties of lithium niobate crystals (optically nonlinear, piezoelectric and electro-optic) makes the resultant micro-resonator extremely suitable for sensing applications, for the production of micro-lasers (if doped with Er or Nd), for nonlinear frequency generation and finally for switching/modulation and tunable spectral filtering in optical telecommunications. The transformation of the initial surface micro-structures to the resulting resonator structure is a temperature dependent process as the surface tension acts on the surface melted layer of the crystal, Experimental investigation and modelling of the thermal treatment as well as investigation of the performance of these micro-resonators is underway to establish full control of the fabrication process for practical applications.

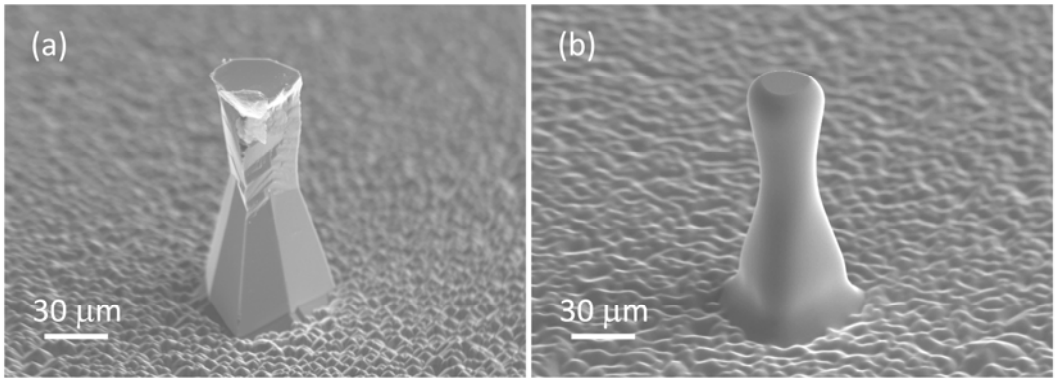

Figure 1: (a) Initial micro-structure, with undercut, fabricated by HF etching of a domain-engineered lithium niobate sample. (b) Resulting structure after thermal treatment at 1253°C for 1 hr.

References

[1] R. Lipowsky, *Springer Proc. in Physics*, Vol. 50 Springer Verlag Berlin, Heidelberg, 158-166 (1990)