Ferroelectric domain inversion has been achieved on the +z and the −z faces of congruent undoped lithium niobate (LiNbO₃) single crystals by direct UV writing using a continuous wave (c.w.) frequency doubled argon ion laser (λ = 244 nm). The width and the depth of the domains were observed to depend on the intensity and the spot size of the laser beam as well as the writing speed. The inverted domain structures were investigated by scanning electron microscopy (SEM), after HF acid differential etching, and piezoresponse force microscopy (PFM) [1]. UV laser inverted domains directly written on a multi-domain crystal (PPLN) show that the PFM contrast of the UV written domains is lower as compared to the bulk domains (Fig. 1b). This indicates that the UV written domains are shallower than 1 µm because any domain depth exceeding ~ 1 µm in LiNbO₃ would appear as bulk in PFM imaging. This is consistent with the extremely small absorption depth of << 1 µm at λ = 244 nm [2].

Although shallow these UV laser written domains can be also remarkably narrow and also they can be fabricated onto any surface independent of the crystal orientation. Driving these surface domains deeper in the crystal by optical or electric field post processing, is currently under investigation.

Fig. 1: (a) Scanning electron microscopy image of the HF etched UV laser inverted domain lines. (b) Piezoresponse force microscopy image of UV-induced domain structures written on a previously periodically poled LiNbO₃ substrate (Λ = 8 µm). The relative contrast indicates that the depth of the UV-written domains is << 1 µm.