Title: New sodo-niobate amorphous thin films: microscale patterning of strong second order optical response by an imprinting thermo-electrical polarization process

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200-300 words abstract:

The synthesis of new amorphous thin films in the Nb_2O_5-Na_2O system prepared by radio frequency sputtering is reported. A range of composition from pure Nb_2O_5 up to 10 at% of sodium has been studied. XRD suggests the amorphous character of the films, and Raman and EDS spectroscopies have confirmed the successful introduction of sodium in the niobate matrix. The resulting films are of good optical quality with high refractive index (2.2 at λ=1 µm) and a wide transparency domain spanning from the visible to mid-infrared (to λ=5 µm) with no scattering.

A thermo-electrical imprinting process has been used to induce second order optical response in the niobate thin films. By characterizing the geometry and the magnitude of the second-order nonlinear (SONL) optical response, a key aspect of thin film's poling mechanisms compared with bulk glasses is demonstrated that lies in the appearance of a charge accumulation at the film/substrate interface and that is described by the Maxwell–Wagner effect. A way to minimize this effect is then proven by promoting an induced built-in static field in the plane of the film using a microstructured electrode. A SONL optical susceptibility as high as 29 pm/V is measured and its geometry and location are controlled at the micrometer scale; it constitutes an improvement of at least one order of magnitude compared with other poled amorphous inorganic materials and is comparable with that of lithium niobate single crystal. This work paves the way for the future design of integrated nonlinear photonic circuits based on amorphous inorganic materials enabled by the spatially selective and high SONL optical susceptibility of these promising and novel optical materials.

50-150 words abstract:

A thermo-electrical imprinting process has been used to induce second order optical response in amorphous sodo-niobate optical thin films. By characterizing the geometry and the magnitude of the second-order nonlinear (SONL) optical response, a key aspect of thin film's poling mechanisms compared with bulk glasses is demonstrated that lies in the appearance of a charge accumulation at the film/substrate interface and that is described by the Maxwell–Wagner effect. A way to minimize this effect is then proven by promoting an induced built-in static field in the plane of the film using a microstructured electrode. A SONL optical susceptibility as high as 29 pm/V is measured and its geometry and location are controlled at the micrometer scale. This work paves the way for the future design of integrated nonlinear photonic circuits based on amorphous inorganic poled materials.