Microstructuring the optical properties in ionic glasses by thermal poling: the influence of the sodium content

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Abstract

In the design of microphotonic devices, it is of the utmost importance to control optical properties at different scales. For this reason, new materials and processes have been developed. Thermal poling induces in ionic glasses strong composition and structural modifications as well as index change and second-order nonlinear (SONL) response which is usually forbidden in such centrosymmetric media.
In this work borophosphate niobium and sodium glasses have been studied. Different content of sodium from 3 at% up to 10 at% have been tested while the ratio between the other compounds has been kept unchanged. In the first place the influence of the sodium content on both the structure and the linear optical properties, namely the index, have been discussed. In the second place the evolution of the linear and nonlinear optical properties induced by thermal poling have been quantified. Strong variations of the index ranging from 0.005 to 0.015 have been observed along with a SONL response (with $\chi(2)$ from 2 pm/V up to 4 pm/V) both function of the initial sodium content. It has consequently been shown that the sodium ratio was a key parameter allowing one to tune the amplitude of the index change as well as the SONL efficiency induced by thermal poling.
Finally, using thermal poling as an imprinting process, structuring of optical functionalities has been controlled at the micrometric scale leading to the conception of an optical grating with both linear and nonlinear responses.

Keywords: thermal poling, optics, microstructuring

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