2.1 Growth of $KNbO_3$ Crystals with Different Dopants and Reduction Treatment and their Characterization

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In the course of the research into the production of reduced $KNbO_3$ new insights regarding the most effective treatment of boules drawn from the melt were found. The parameters (reducing atmosphere, electric field, etc.) could be determined in order to produce high quality photorefractive crystals with fast response times. The search for dopants other than Fe that would increase the photorefractive sensitivity was advanced by evaluating the differently doped samples produced one year ago.

A number of different dopants (Mn, Ni, Cu, Ce, and Rh) were introduced into $KNbO_3$. Subsequent photorefractive characterization showed these crystals to have interesting properties such a wavelength dependent photoexcited charge carrier signs and enhanced sensitivities at visible wavelengths. For phase conjugation applications at wavelengths around 500 nm the most promising dopants are Mn, Ni, Fe, and co-doping with Mn-Rh.

The production of reduced Fe doped and pure $KNbO_3$ advanced significantly. Subsequent characterization of optical quality samples involving absorption, dark conductivity, photoconductivity, and effective trap density measurements showed that the treated samples had electrons as the dominant photoexcited charge carriers where untreated samples are hole conductive. This effect is accompanied by the appearance of an additional absorption band around 500 nm. The effective trap density is similar in the untreated and treated samples but EPR measurements showed the Fe^{3+} signal to disappear in the treated crystals. Reduced samples showed strong beam fanning that arises from defect scattering accompanied by self pumped phase conjugation. The model whereby the low oxygen pressure in the gas mixture induces oxygen vacancies in $KNbO_3$ which then reduce Fe^{3+} to Fe^{2+} through charge compensation is correct.

Enhanced response times where observed in samples that suffered the most drastic treatment. In general treated Fe doped $KNbO_3$ has similar photorefractive response times to untreated crystals. The higher the Fe content of a boule the more strongly reducing the treatment must be to achieve similar results to weakly doped or to nominally pure crystals. Further work will concentrate on increasing the number of oxygen vacancies in Fe doped $KNbO_3$.