

Nanooptics and nanophotonics

Effect of aluminum oxyhydroxide nanoparticles incorporation on nonlinear optical response of KDP single crystals

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A novel composite system based on KDP single crystals with embedded nanoparticles (NPs) of nanostructured oxyhydroxide of aluminum ($\text{Al}_2\text{O}_3 \cdot n\text{H}_2\text{O}$, NOA) was grown. The optical characterization of the obtained material showed the high optical quality and homogeneity of the nanocomposites. The zonal structure with a spatial period $\sim 4 \mu\text{m}$ independent on the concentration of NPs in KDP:NOA crystals was observed [1]. Recently it was shown that the incorporation of NOA NPs leads to the sign inversion and enhancement of the nonlinear optical (NLO) response efficiency versus the nominally pure KDP matrix under the excitation of pulsed laser irradiation at 1064 nm [2].

In this work the effect of NOA NPs concentration on refractive NLO response of KDP single crystals was studied by the self-action of picosecond (30 ps) laser pulses at 532 nm. It was shown that for the pure KDP crystals cut from the pyramidal growth sector the self-defocusing effect was observed. The incorporation of the NOA NPs to KDP matrix leads to the sign turn to self-focusing at peak laser intensity range $< 50 \text{ MW/cm}^2$. The efficiency of the processes significantly depends on the alumina NPs concentration – at NOA NPs concentration $10^{-3} \text{ wt.}\%$ the almost total compensation of the KDP matrix NLO response by the NPs one was observed. The maximum gain of the refractive NLO response was observed for the crystals with NOA NPs concentration $10^{-5} \text{ wt.}\%$ and $10^{-4} \text{ wt.}\%$ ($\text{Re}(\chi^{(3)}) \sim 2 \cdot 10^{-10} \text{ esu}$).

Similarly to the results obtained in KDP with anatase NPs we suppose that the observed efficient NLO response manifestation indicates the enhancement of the second harmonic generation efficiency in the KDP single crystals with NOA NPs.

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2. Pritula I.M., Kosinova A.V., Bezkravnaya O.N., Kolybaeva M.I., Puzikov V.M., Lopin A.V., Tkachenko V.F., Kopylovsky M., Yatsyna V.O., Gayvoronsky V.Ya. Linear and nonlinear optical properties of KDP crystals with

incorporated $\text{Al}_2\text{O}_3 \cdot n\text{H}_2\text{O}$ nanoparticles// Opt. Mat.-2013.-**35**.-P.2429-2434.