YTTERBIUM IONS RECHARGING PROCESSES IN $Yb:Y_3Al_5O_{12}$ SINGLE CRYSTALS AND FILMS

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The recharging processes $Yb^{3+} \leftrightarrow Yb^{2+}$ in highly doped $Yb:Y_3Al_5O_{12}$ crystals and films under high temperature reduction und oxidation treatments were experimentally studied. Single crystals of $Yb:Y_3Al_5O_{12}$, $Yb_3Al_5O_{12}$ (YbAG), $Ni:Yb_3Al_5O_{12}$, $K:Yb_3Al_5O_{12}$ grown by Czochralski technique as well as single crystalline films of $Yb:Y_3Al_5O_{12}$ grown by liquid phase epitaxy were investigated by means of fluorescence lifetime measurements and optical spectrometry. The recharge process $Yb^{2+} \rightarrow Yb^{3+}$ was found to be reversible or non-reversible depending on the presence of additional (doping or impurity) ions. Indeed, the reduction process $Yb^{2+} \rightarrow Yb^{3+}$ does not occur in previously oxidized un-doped and doped with 2+ or 3+ valent ions Yb:YAG crystalline materials.

Kinetics of recharge processes $Yb^{2+} \rightarrow Yb^{3+}$ in $Yb:Y_3Al_5O_{12}$ epitaxial films under thermo-chemical treatment in oxidizing atmosphere were studied by means of *in-situ* high temperature spectroscopy. It was revealed that course of $Yb^{2+} \rightarrow Yb^{3+}$ recharge process in films differs from that in bulk crystals, particularly, in the form of recharge kinetics and its rate. These differences were shown to be related with differences in the reaction rate on the sample surface and determined by structural perfection of the sample surface. The rate of $Yb^{2+} \rightarrow Yb^{3+}$ recharge process was found to be much higher in bulk crystal samples with damaged surface structure caused by mechanical polishing than in epitaxial films with atomically smooth surface.

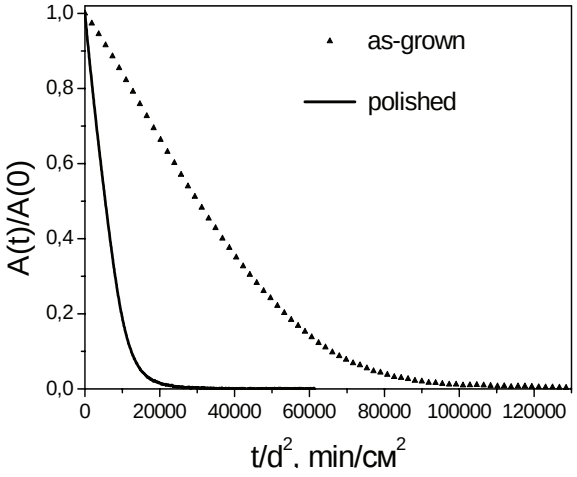

Fig. 1. Relative changes of absorption vs t/d^2 (where t is oxidation time; d is sample thickness) obtained on as-grown and polished samples of epitaxial film $Yb:Y_3Al_5O_{12}$ during the recharge process $Yb^{2+} \rightarrow Yb^{3+}$ at 950ºC.