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## STIMULATED EMISSION OF NEODYMIUM IONS IN QUARTZ GLASS

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Stimulated emission from neodymium-doped quartz glass having a coefficient of thermal expansion $6\times10^{-7}$ $deg^{-1}$ is reported for the first time. It is found that this material is not inferior in its spectral and luminescence characteristics to commercial silicate glass with neodymium.

In the few papers describing attempts to introduce rare-earth ions in quartz glass for the purpose of obtaining an effective luminescenct material with high thermal endurance, it is noted that the activator, particularly $Nd^{3+}$, is not uniformly distributed in the matrix, and experiences in this case a strong concentration quenching [1, 2].

The maximum activator concentration that could be obtained in quartz glass without visible stratification was quite negligible (tenths of a per cent by weight), but the luminescence quantum yield was much lower ($\sim$ 1%) than at the same concentration in commercial silicate glasses (20 - 30%). Nonetheless, the practical need for lasing material with high thermal endurance have induced us to continue the search in this direction.

We report here the first attained lasing of $Nd^{3+}$ in quartz glass with a thermal-expansion coefficient $6\times10^{-7}$ $deg^{-1}$. The use of a new technique of introducing the activator into the quartz-glass matrix, in conjunction with addition of a buffer component, has made it possible to obtain samples without stratification (without opalescence and dulling), with activator concentrations up to 1 mol.% $Nd_2O_3$. The investigation of the absorption and luminescence spectra, of the lifetime and of the quantum yield, and of the oscillator strengths and of the stimulated-transition cross section, have shown that when it comes to these parameters the quartz glass is not inferior to commercial multicomponent silicate glasses with neodymium (Fig. 1, table).

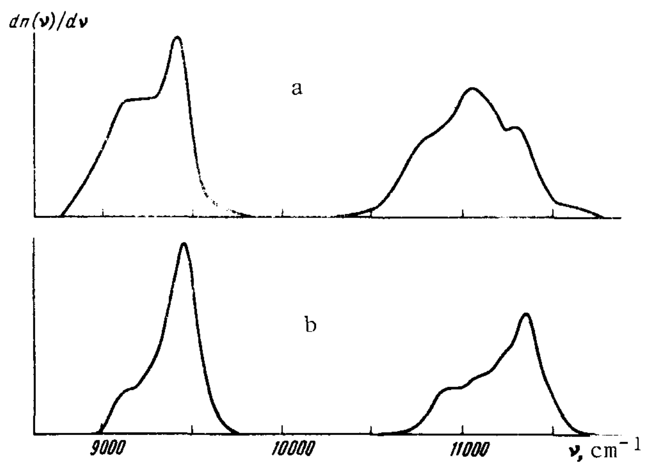


Fig. 1. Luminescence spectrum near 0.9 and 1.06 μ: a) quartz glass with neodymium, b) commercial glass (GLS-2) at 300°K. The spectra are corrected for the spectral sensitivity of the receiver.

We have performed lasing experiments on samples of 10 mm diam and 100 mm length, with $Nd_2O_3$ concentration 1.3 wt.%. In a nearly-confocal resonator, with mirrors of 500 mm radius, we obtained the spectrum and time variation shown in Figs. 2a and 2b. The transmission of the output mirror was 5%. The generation threshold was reached at 330 J of electric pump energy. The UV component of the pumping light was not filtered out. The center of the lasing spectrum corresponds to 1062 nm, which coincides with the maximum of the luminescence band (Fig. 1). Attention is called to the appreciable width of the spectrum even at slight excesses above threshold. At a fourfold excess above threshold, the width of the spectrum is approximately 100 Å. This is due primarily to the appreciable inhomogeneous broadening of the $^4F_{3/2} \rightarrow {}^4I_{11/2}$ band of $Nd^{3+}$ in the quartz glass. The relatively high generation spectrum is due, besides to non-optimal test conditions, also to the appreciable inactive absorption in the samples at the generation wavelength. The use

| Glass | Lifetime, μsec | Quant. yield, rel. units | Stim. emiss. cross sect., $10^{-20}cm^2$ |
|---|---|---|---|
| Silicate glass | 550 | 1.0 | 2.5 |
| Quartz glass | 420 | 0.75 | 2.5 |

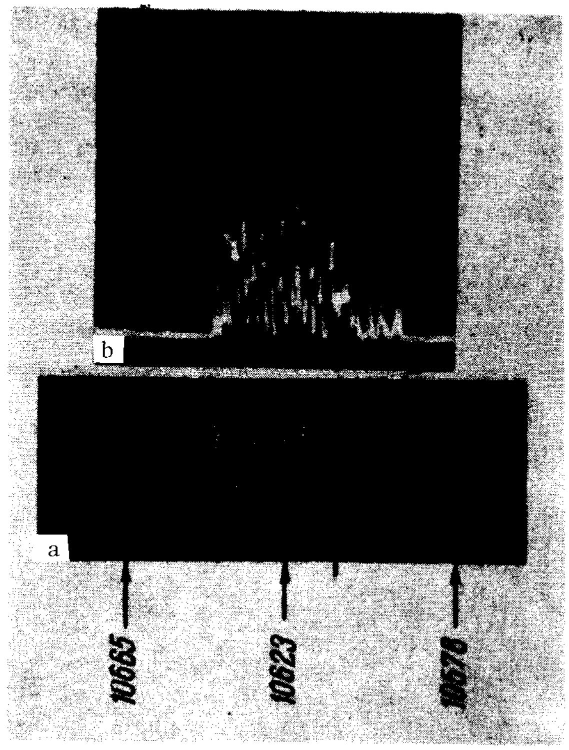


Fig. 2. a) Generation spectrum of quartz glass with Nd at fourfold excess over threshold; b) oscillogram of generation intensity of quartz glass with Nd at slight excess above threshold, T = 300°K.

of purer initial materials and of sterile fusing conditions will greatly imrpove the generation parameters.

It should be noted in conclusion that the investigated samples retain the main advantages of quartz glass, namely the high thermal endurance (higher than 800°C) and transparency in the ultraviolet. The latter makes it possible to use the ultraviolet absorption bands of neodymium for the pumping. The high thermal endurance of the quartz glass gives grounds for hoping to realize continuous lasing with relatively simple cooling conditions.


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## COHERENT EFFECTS IN THE PROPAGATION OF AN ULTRASHORT LIGHT PULSE IN A MEDIUM WITH RESONANT TWO-PHOTON ABSORPTION


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An exact solution is obtained for the problem of the propagation of a light pulse of duration $\tau_p \ll T_2$, under conditions of two-photon resonance ($2\omega = \omega_{21}$). It is shown that the decomposition of the initial pulse into a number of components followed by a reduction of the component duration can be used to obtain sequences of ultrashort pulses of duration $\tau_p \lesssim 10^{-14}$ sec.


Coherent transparentization (bleaching) of substances by propagation of ultrashort light pulses having a doubled carrier frequency ($2\omega$) close to the frequency $\omega_{21}$ of the resonant transition in the medium have been under investigation recently both theoretically [1, 2] and experimentally [3].