Vol. A54 (1978) ACTA PHYSICA POLONICA No 2

SPECTROSCOPIC PROPERTIES OF Nd^{+3} DOPED ARSENATE GLASSES

By Z. Mazurak, W. Stręk and B. Jeżowska-Trzebiatowska

Institute for Low Temperature and Structure Research, Polish Academy of Sciences, Wrocław*

(*Received December 19, 1977*)

Arsenate glasses having the composition $(Nd_2O_3)_x : (Y_2O_3)_{1-x} : (As_2O_5)_y$ were prepared. It was found that the Nd doped arsenide glasses are characterized by the low concentration quenching of the neodymium fluorescence.

1. Introduction

In recent years interest grew in the field of spectroscopy of highly concentrated neodymium materials yielding efficient optical excitation of small volume of samples. The first material discovered which was characterized by a high concentration of Nd^{+3} ions (4.1×10^{21} cm^{-3}) was neodymium pentaphosphate (NdP_5O_{14}) [1] of which the emission cross section, line width and spontaneous lifetime are comparable to those in Nd : YAG [1–3].

Similar properties have been observed in many phosphorous compounds doped with neodymium ions e.g. $KNdP_4O_{12}$ [4], $K_3Nd(PO_4)_2$ [5], $Na_2Nd_2Pb_6(PO_4)_6CL_2$ [6]. Batygov et al. [7] have shown that phosphorous glasses doped with neodymium ions are also characterized by small concentration quenching (the lifetime at a concentration of 2.7×10^{21} ions per cm^3 was 80 μsec). Similar behaviour of neodymium concentration quenching has been found for tellurite glasses [8].

This paper reports on the first attempt to measure the fluorescence quenching in Nd-doped arsenate glasses. The results obtained evidently revealed that these glasses are characterized also by a small concentration quenching of neodymium fluorescence.

* Address: Instytut Niskich Temperatur i Badań Strukturalnych PAN, Plac Katedralny 1, 50-950 Wrocław, Poland.

2. *Experimental*

The (0.87−0.98) $As_2O_5 \cdot (0.13-0.02\, Nd_2O_3)_x(Y_2O_3)_{1-x}$ glasses were prepared by melting a mixture of the appropriate oxides in a quartz tube at 750°C for 30 min and next by rapid cooling them down to room temperature. The details about the glass composition are given in Table I.

TABLE I

Chemical composition of neodymium doped arsenate glass

	Composition [weight %]	Concentration [10^{20} cm^{-3}]	Lifetime [μsec]
1	$13.04Nd_2O_3:86.96As_2O_5$	18.69	30
2	$7.38Nd_2O_3:1.36Y_2O_3:91.26As_2O_5$	10.57	41
3	$5.91Nd_2O_3:2.72Y_2O_3:91.37As_2O_5$	8.46	48
4	$4.28Nd_2O_3:3.93Y_2O_3:91.79As_2O_5$	6.13	90
5	$3.20Nd_2O_3:4.46Y_2O_3:92.34As_2O_5$	4.58	105
6	$3.06Nd_2O_3:2.81Y_2O_3:94.13As_2O_5$	4.38	122
7	$2.16Nd_2O_3:3.50Y_2O_3:94.34As_2O_5$	3.09	57
8	$1.50Nd_2O_3:4.14Y_2O_3:94.36As_2O_5$	2.14	160

From the glass batch, 1—2 mm thick samples were cut and polished and next used for the spectroscopic measurements. The optical absorption spectra of the glasses were measured on a Cary 14 Spectrophotometer and the fluorescence spectra were measured on a C. Zeiss Jena GDM-1000 monochromator equipped with a dry-ice cooled S-1 photomultiplier. The source of excitation was a HBO-200 high pressure mercury lamp. The

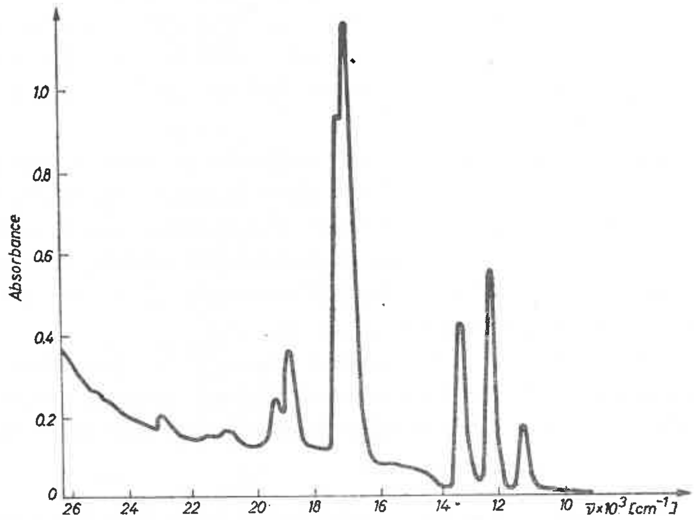

Fig. 1. Absorption spectrum of arsenate glass doped with neodymium

fluorescence decay time was measured with a TRW Decay Time Fluorometer where light source was replaced by a HBO-200 lamp with an averaged pulse duration of 20 μs.

The corresponding absorption and fluorescence spectra of Nd-doped arsenate glasses are shown in Figs. 1 and 2. The observed lifetime as a function of Nd concentration in arsenate glass at room temperature is shown in Fig. 3.

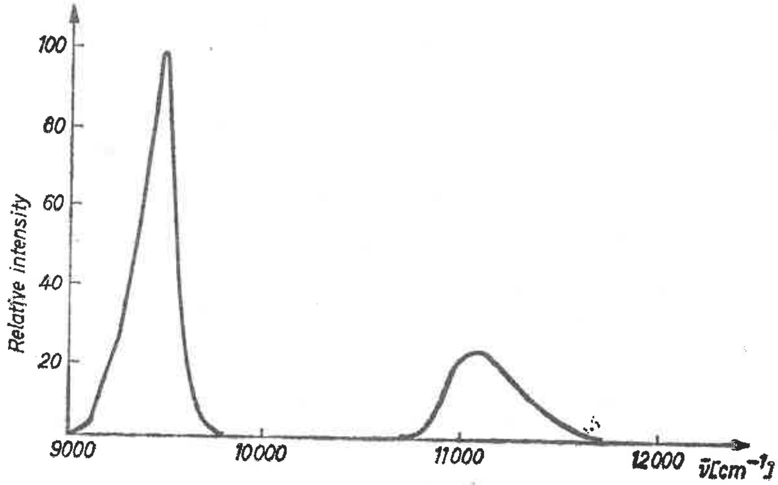

Fig. 2. Fluorescence spectrum of arsenate glass doped with neodymium

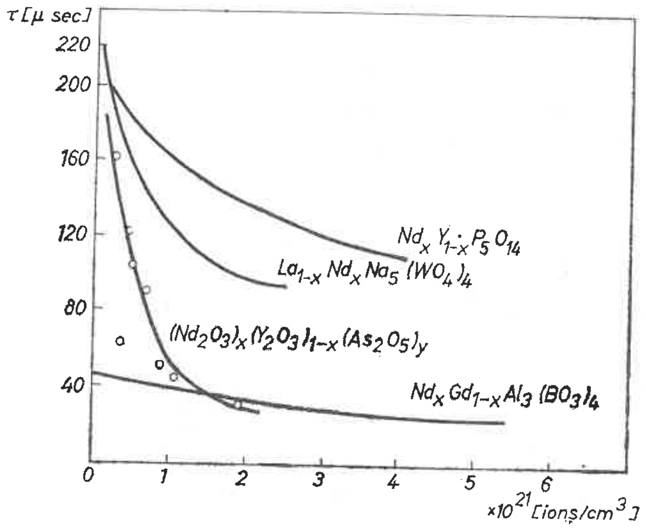

Fig. 3. Concentration dependence of Nd^{+3} fluorescence in arsenate glass, $Nd_xY_{1-x}P_5O_{14}$ [3], $La_{1-x}Nd_xNa_5(WO_4)_4$ [9], $Nd_xGd_{1-x}Al_3(BO_3)_4$ [10]

It is seen from Fig. 3 that the fluorescence lifetime of Nd^{+3} remains quite long even at a doping level beyond 10^{21} cm^{-3} like in the other highly concentrated neodymium materials, such as $Nd_xY_{1-x}P_5O_{14}$[3], $La_{1-x}Nd_xNa_5(WO_4)_4$ [9], $Nd_xGd_{1-x}Al_3(BO_3)_4$[10]. The fluorescence lifetime of Nd^{+3} in tellurite glass at a concentration of 10^{21} cm^{-3} was found to be about 50 µsec whereas in arsenate glass it was 100 µsec.

On the basis of the results presented here it could be believed that the arsenate glass shows good promise as a new laser host material primarily in such applications where high neodymium concentration is desirable.

The authors are grateful to C. Szafrański, M.Sci., for fluorescence measurements.

REFERENCES

[1] M. Blätte, H. G. Danielmayer, R. Ulrich, *Appl. Phys.* **1**, 275 (1973).
[2] H. P. Weber, F. P. Liao, B. C. Tofield, *IEEE J. Quantum Electron.* **10**, 505 (1974).
[3] W. Stręk, C. Szafrański, E. Łukowiak, Z. Mazurak, B. Jeżowska-Trzebiatowska, *Phys. Status Solidi* (a) **41**, 547 (1977).
[4] T. Yamada, K. Otsuka, J. Nakano, *J. Appl. Phys.* **45**, 5096 (1974).
[5] H. Y. P. Hong, S. R. Chinn, *Mater. Res. Bull.* **11**, 421 (1976).
[6] J. C. Michel, D. Morin, F. Auzel, *C. R. Acad. Sci. Paris* **281**, 445 (1975).
[7] S. H. Batygov et al., *Kvantovaya Elektron.* **3**, 2233 (1976).
[8] S. Singh, L. G. Van Uitert, W. H. Grodkiewicz, *Opt. Commun.* **17**, 315 (1976).
[9] H. Y. P. Hong, K. Dwight, *Mater. Res. Bull.* **9**, 775 (1974).
[10] H. Y. P. Hong, K. Dwight, *Mater. Res. Bull.* **9**, 1661 (1974).