# Effect of metal oxides on structure and properties of borate - phosphate glasses

**Nedilko S.G.**[1], **Scherbatskii V.P.**[1], **Stus N.V.**[1], **Yaschuk V.P.**[1], **Gomenyuk O.V.**[2], **Sheludko V.I.** [2], **Androulidaki M.**[3], **Manousaki A.**[3], **Papadopoulos A.**[3], **Stratacis M.**[3]

[1] *Taras Shevchenko National University of Kyiv, 64/13 Volodymyrska str., 01601 Kyiv, Ukraine*
*Email: SNedilko@univ.kiev.ua*
[2] *O. Dovzhenko Hlukhiv National Pedagogical University, Hlukhiv, Ukraine*
[3] *Institute of Electronic Structure & Laser (IESL) of Foundation for Research & Technology Hellas (FORTH), Heraklion Crete, Greece*

## Introduction

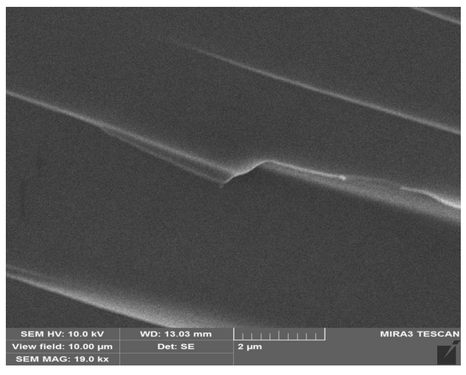
Materials and composites, which possess luminescent properties, have various fields of application: industry, science and technology, everyday life, etc. Some of them now are developed for advanced opto-electronic devices, white light-emitting diodes (WLED) and solar cells. Up to date, the new lighting and display devices such as light-emitting diodes (LEDs), plasma display panels (PDPs), and field emission displays (FEDs) have been proposed or developed in industry, which result in great interest in searching novel phosphors for mentioned applications.

## Synthesis and sample characterization

The series of glasses with compositions of the common formulae $mNa_2O$ - $nB_2O_3$ -$kP_2O_5$ (M = Pb or Zn) were prepared and studied. The molar composition of alkali phosphate-borate glass-forming matrix was close to 40% $Na_2O$ - 20% $P_2O_5$ -40 % $B_2O_3$. The amount of the Pb or Zn was in the range of 1 – 25 mol%. Below the samples are marked content of PbO or ZnO oxides. All the samples were made by the melt-quenching procedure .

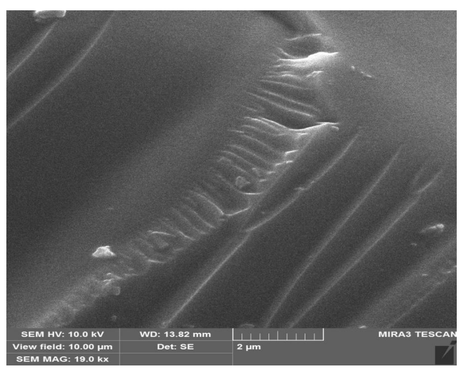
The glasses were characterized by SEM, XRD, FTIR, UV-VIS and luminescent spectroscopy.

## SEM images: morphology and structure



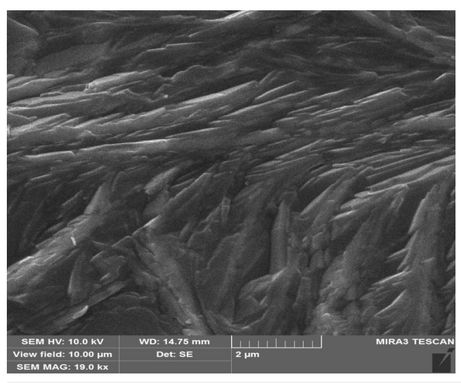

PbO : 5%

The glass that is of high quality



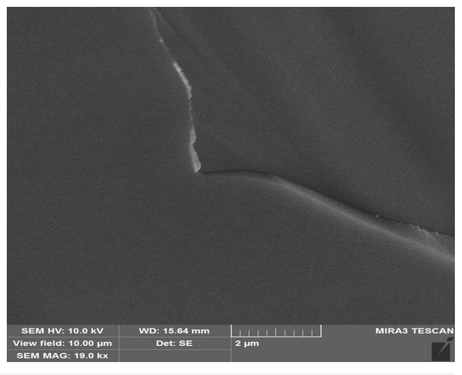

PbO : 10%

High quality and crystalline inclusions




PbO : 15%

The glass that is of low quality

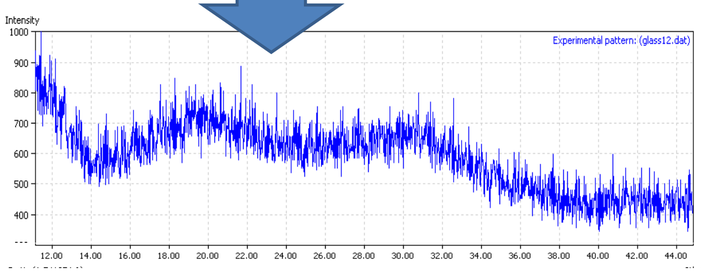



ZnO : 5%

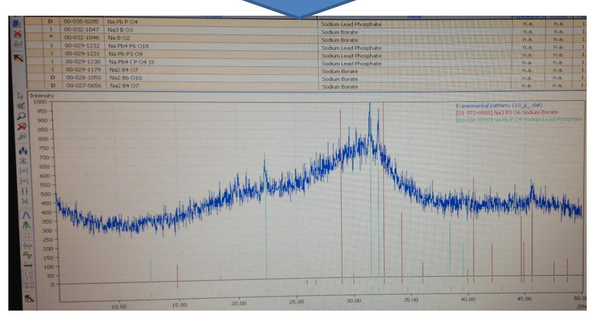
The glass that is of high quality

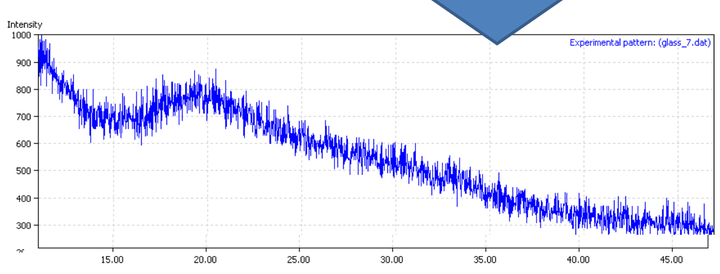
The observed wave-steps are the result of breaking a large piece of the glasses.

## XRD and Crystal structures




This is typical XRD pattern of amorphous phase

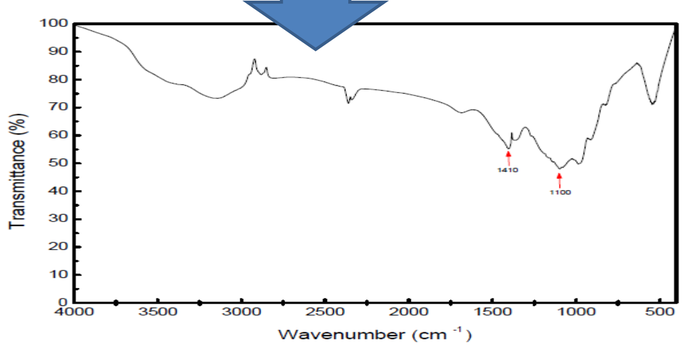




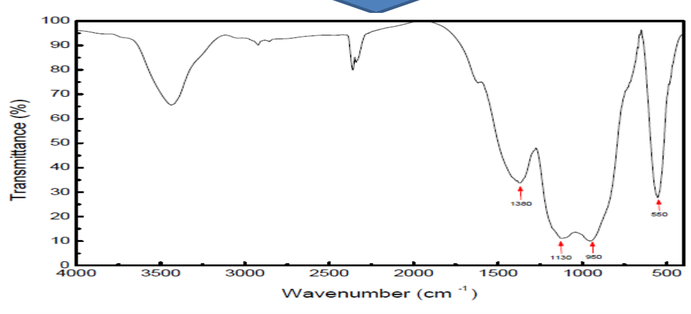

This is typical XRD pattern of amorphous phase

Matching PbO: 10 - 15 % XRD patterns to possible crystal phases reflects has showed presence of the $NaPbPO_4$ and $Na_3B_3O_6$ crystal inclusions.

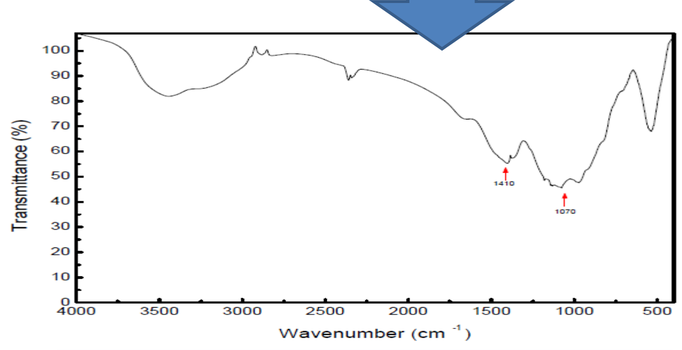
## FT IR spectra




Below 620 cm−1: the vibration of PbO

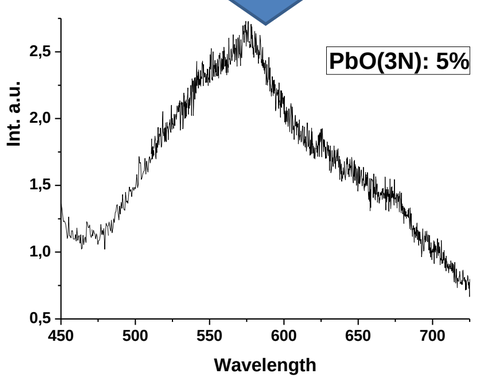


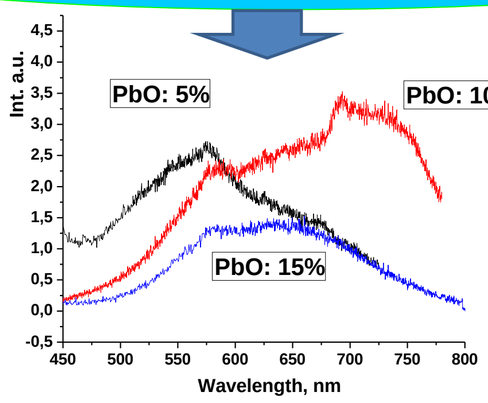

1300 – 1700 $cm^{-1}$: B–O–B vibration in [$BO_3$] triangles;

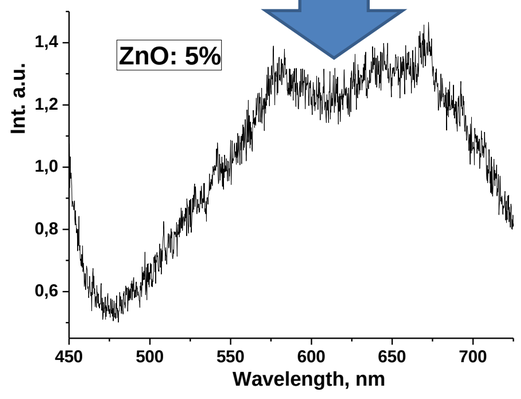



Below 500 cm−1: bands related with $Zn^{2+}$ and $Pb^{2+}$ ions

## Photoluminescence, excitation at 405 nm




Observed PL has to be related with complex centers which include defects of the structure: oxygen vacancy, non-bridged Oxygen atoms and $Pb^{2+}$, $Zn^{2+}$ – ions.

## Conclusions

1. Melting temperature of the starting charge depends mainly on the *m*/*n*/*k* ratio, while amount of the PbO or ZnO influences microstructure and quality of the glasses.
2. Oxide fillers influence crystallinity of the glasses.
3. IR spectra show the effect of the heavy Pb and Zn atoms on the binding of the atoms in borate and phosphate molecular groups.
4. The PL has to be related with complex centers which include defects of the structure: oxygen vacancy, non-bridged Oxygen atoms and $Pb^{2+}$, $Zn^{2+}$ – ions.

8th International Conference “Nanotechnology and Nanomaterials” (NANO-2020), 26 - 29 August 2020 , Lviv, Ukraine