Ain Shams University
Faculty of Science

Effect of ionizing radiation and heat treatment on oxide glass for some practical applications

A Ph.D. Thesis submitted
To

Chemistry Department
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By

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Effect of ionizing radiation and heat treatment on oxide glass for some practical applications

A Thesis
Submitted to the Faculty of Science, Ain Shams University,
in Partial Fulfillment of Requirements of phD Degree in
Inorganic Chemistry

By

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ABSTRACT

Glasses from the system [47 P_2O_5 - 23 Na_2O - 6 Al_2O_3 - (24-x) PbO- x MoO_3] where x=0.5, 1, 3 %wt have been prepared using the conventional melting at temperature 1000-1100 ^{0}C then annealed at 400 ^{0}C. Also the formed glass samples were heat treated using three different temperatures 350, 450 and 550 ^{0}C according to the DSC results. The x-ray diffraction analysis showed that glass samples are amorphous even after heat treatment. Also the obtained XRD results showed there is no crystalline phase observed after heat treatment. The final composition was obtained by EDX measurements after melting process. FTIR studies were determined before and after being exposed to gamma radiation at different doses (2.5, 10, 50 kGy). The results of absorption measurements showed that the main bands at 1064 and 887 cm^{-1} of pyrophosphate and metaphosphate units, respectively. Also radiation showed minor changes in the wavenumber of the IR bands. Spectral absorbance and transmittance were recorded in the spectral range (200- 1000 nm) to investigate the effects of different molybdenum concentrations and gamma radiation on the

prepared glass samples. The Absorption dispersion parameters such as: Urbach energy and optical energy gap for direct and indirect transition were determined. The values of E_g lie between 2.31-4.62 ev.

The durability of the phosphate glass samples was tested in 0.1N HCl and distilled water before and after being radiated with 50 kGy. The chemical durability results of the glass samples were obtained by calculating the weight loss percentage, also the change in the values of the pH of the corroded solution was measured. The morphology of the surface of the glass samples were examined by SEM. The results showed that the most durable glass sample was the phosphate glass with 3 %Mo.

Electron spin resonance (ESR) measurements were studied before and after being exposed to different radiation doses (2.5, 10, 50, 80 kGy) showing that molybdenum is found in the glass network as Mo^{5+} not as Mo^{3+}. The ESR results were supported by measuring the electrical conductivity of the prepared glass. Electrical conductivity was demonstrated for all glass samples before and after

radiation. It was found that electrical conductivity in the glass samples occurred by ionic and electronic conduction which can be cleared by the density results. Density was measured using Archimedes principle at room temperature and it was found that the density decreased by increasing the molybdenum content, also molar volume and specific volume were calculated.

To recognize the effect of heat treatment on the characteristic vibrational bands of the structural building units of all the glass samples, we studied FTIR spectra at different heat treatment temperatures (350, 450 and 550 ^{0}C). Also studying the UV and ESR spectra after the effect of heat treatment and changes on the glass surface that could be illustrated by SEM images.

***Key words*:** phosphate glass, molybdenum oxide, chemical durability, optical measurements, ESR, electrical conductivity and density.

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