



XPS STUDY OF IRON SODIUM TELLURITE GLASSES

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Nanos
2004

7th ESG Conference
on
Glass Science and Technology

25-29 April 2004, Athens, Greece

Motivations

- Tellurite based oxide glasses have potential applications in optical materials.
- Transition metal doped oxide glasses are also of scientific interest due to their semiconducting and magnetic properties
- No structural work has been done on this glass system

Objectives

Use the XPS technique to investigate:

- Structural role of Fe_2O_3 in tellurite glasses
- Identify the various structural units of Te atoms in these glasses
- Identify the presence of the two valence states of Fe ions in these glasses

Glasses composition

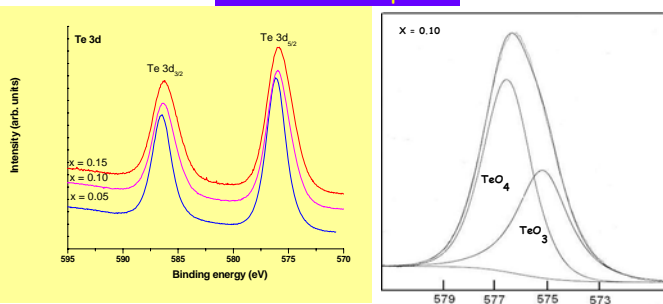


Sample preparation

- Stoichiometric amounts of Fe_2O_3 , Na_2CO_3 (for Na_2O) and TeO_2 were melted in alumina crucibles between 850-900 °C depending on the composition for one hour
- XPS measurements were performed on glass rods fractured in UHV ($\sim 10^{-10}$ mbar). Core level spectra of Te 3d, O 1s and Fe 2p were recorded and analyzed

Results and Discussion

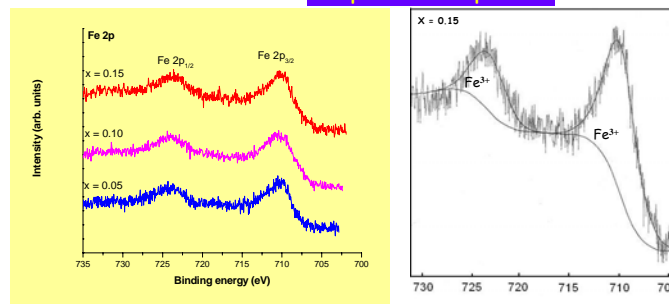
Te 3d Core Level Spectra



x	Te 3d _{5/2}		TeO ₃		TeO ₄		TeO ₃ /total Te
	BE	FWHM	BE	FWHM	BE	FWHM	
0.05	576.15	2.13	-	-	576.15	2.13	0
0.10	576.03	2.59	575.14	2.20	576.21	2.10	26.8
0.15	575.92	2.82	575.10	2.20	576.20	2.10	38.8
TeO ₂	576.10	2.07	-	-	576.10	2.07	0

XPS indicates a slight decrease in binding energies of Te 3d spectra with an increase in Fe_2O_3 content. A fitting of the Te 3d_{5/2} with two contributions reveal the existence of both TeO_4 and TeO_3 units in these glasses

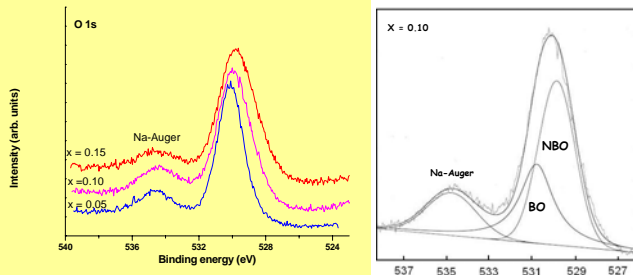
Fe 2p Core level Spectra



x	Fe 2p _{3/2}		Fe 2p _{1/2}		ΔE (eV)
	BE	FWHM	BE	FWHM	
0.05	710.10	3.82	723.78	4.51	13.68
0.10	710.07	4.32	723.46	3.93	13.39
0.15	710.04	3.91	723.39	4.21	13.35
Fe_2O_3	710.7	4.3	-	-	13.60
FeO	709.2	4.3	-	-	-

XPS indicates that the BE of the Fe 2p_{3/2} does not vary much with increase in Fe_2O_3 content and Fe^{3+} is the only oxidation state of Fe ions in these glasses

O 1s Core level Spectra



x	O 1s		BO		NBO		NBO/TO
	BE	FWHM	BE	FWHM	BE	FWHM	
0.05	530.13	1.9	530.5	1.70	529.86	1.80	54.9
0.10	530.13	2.42	530.8	1.75	529.88	2.0	66.4
0.15	529.96	2.65	530.9	1.75	529.95	2.1	82.1
TeO ₂	530.32	1.59	530.32	1.59	-	-	-

Conclusions

- The results are summarized as follows
- Te exist in both TeO_4 trigonal bipyramid and TeO_3 trigonal pyramid units
 - Fe ions exist predominantly in Fe^{3+} state for all compositions
 - NBO increases with increase in Fe_2O_3 content in the glass network. The measured and calculated number of NBO agrees well considering Fe_2O_3 as network modifier.

$$\frac{NBO}{TO} = \frac{6(0.1+x)}{1.7+x}$$

