

## CHAPTER 5 CONCLUSION

In this dissertation, the soda lime silicate glasses doped with  $\text{MnO}_2$  were prepared by using high purity  $\text{SiO}_2$ ,  $\text{Na}_2\text{O}$ ,  $\text{CaO}$  and  $\text{MnO}_2$  in the composition range of (mol%)  $(65-x)\text{SiO}_2 : 25\text{Na}_2\text{O} : 10\text{CaO} : x\text{MnO}_2$  where  $0.0 \leq x \leq 0.5$ . All chemical composition was finely powder and then mixed in whole of composite. Batches for producing 30 g of glass were melted in high purity alumina crucibles in a laboratory electric furnace at 1200, 1300, 1400 and  $1500^\circ\text{C}$  with soaking time for 3 h. Afterwards, the melts were quickly poured onto a preheated stainless steel mould, annealed at  $500^\circ\text{C}$  for 3 hours, and cooled down to room temperature, respectively. Finally, the as-prepared glass samples were cut and then finely polished to a dimension of  $1.0 \times 0.5 \times 0.3 \text{ cm}^3$  for further studied.

### 5.1 Density and Molar Volume

The glasses density increases with increasing concentration of  $\text{MnO}_2$  indicates that replacing  $\text{SiO}_2$  by addition of a small amount of  $\text{MnO}_2$  results in the increase of the average molecular weight of oxide ions in the glass due to  $\text{MnO}_2$  has a higher relative molecular mass than that of  $\text{SiO}_2$ . In the soda lime silicate glasses, the density of the glass samples as a function of the melting temperature and concentration of  $\text{MnO}_2$  content in the glasses. It is observed that the density increases with increasing melting temperature and concentration of  $\text{MnO}_2$ . The molar volume depends on both the rates of change of density and molecular weight. However, the molar volume decreases when the melting temperature is increased for both soda lime silicate glasses due to the decrease in the bond length or inter-atomic spacing between the atoms which may be attributed to the increase in the stretching force constants of the bonds inside the glass network. This indicates that the structure becomes more compacted.

### 5.2 UV-Visible Absorption Study

The absorption bands are observed in the spectrum with peaks at 495 nm. This absorption band is assigned to a single allowed  ${}^5\text{E}_g \rightarrow {}^5\text{T}_{2g}$  transition which it arises from the manganic ions ( $3d^4$  configuration) in octahedral symmetry. However, it is known that the most common manganese ions found in oxide glasses are manganous and manganic ions. In these absorption spectra, it cannot observe the band for the manganous ions at room temperature. Because the manganous ions have a  $3d^5$  configuration and all transitions are spin-forbidden and therefore give a low intensity compared with that of the manganic ions. The color of a manganese containing glass will be determined by the equilibrium between the purple – generating  $\text{Mn}^{3+}$  form and the essentially non-coloring  $\text{Mn}^{2+}$  form. In soda lime silicate glasses, the manganese ion gives a purple coloration due to the absorption spectrum shows a single broad band at 495 nm.

### 5.3 CIE L\* a\* b\* Color Index

The undoped glass sample was colorless while the MnO<sub>2</sub> doped glasses were color change. They have yellowish at low MnO<sub>2</sub> concentration and change to dark purple color in soda lime silicate glasses due to the spectrum with peaks at 495 nm, which absorb green and yellow color spectra and transparent violet and red color spectra. The brightness, L\* or the reflective values were decrease when the concentration of MnO<sub>2</sub> doping increase. The relations between color of glass sample and melting temperature have not significant.

### 5.4 Refractive index, Molar polarizability and Optical Basicity

The refractive index increases with increasing melting temperature. This result are show similar trend with density result. The molar refraction and the reflection loss depend on both the rates of change of density and refractive index. In soda lime silicate glasses, the dielectric constant, optical dielectric constant, molar refraction and the reflection loss are increases with increasing concentration of MnO<sub>2</sub>. The molar refraction is related to the structure of the glass and it is proportional to the molar polarizability of the material. It is calculated that the molar polarizability increases with increasing concentration of MnO<sub>2</sub>, the relation between molar polarizability and melting temperature have not significant. The molar polarizability have results are similar with density and refractive index of glass samples. The results show that the refractive index of the glass does not only depend on the density but also the electronic polarizability of the glass. The increase of polarizability results in the increase of optical basicity and consequently the refractive index. A higher optical basicity of MnO<sub>2</sub> than that of SiO<sub>2</sub>, the doped glass is expected to possess higher refractive indices.