## List of Figures

1.1 Formation of Glass (after Jones [1956]) .............................................. 3

2.1 Experimental setup of a diffraction experiment ................................. 15

3.1 Geometric focussing conditions of an X-ray Diffractometer ............... 29

3.2 Ray Diagram of an X-ray Diffractometer ........................................... 31

3.3 Schematic of the High-Q Diffractometer ........................................... 33

3.4 Ray diagram of the diffraction measurement of a plane sample in transmission geometry .......................................................... 37

3.5 Schematic of the FTIR-8001 spectrophotometer .................................. 44

3.6 Ray Diagram of UV spectrophotometer 119 ....................................... 45

3.7 Setup of A.C susceptibility measurements .......................................... 52

4.1 X-ray diffraction pattern of WTR4, WTR15 and WTR46 ....................... 62

4.2 \(I(Q)\) of WTR22, WTR30 and WTR35 obtained using X-rays ............... 63

4.3 \(I(Q)\) of Basic glass obtained using X-rays ....................................... 64

4.4 \(D(r)\) WTR22, WTR30 and WTR35 obtained using X-rays .................... 65

4.5 \(i(Q)\) of WTR46 and the Basic glass obtained using neutrons (neutron data) 68

4.6 \(i(Q)\) of WTR22, WTR30, WTR35 and WTR62 glass obtained using neutrons 69

4.7 \(D(r)\) of WTR62, WTR22, WTR30 and WTR35 glasses (neutron data) ........ 70

4.8 Fit to the basic glass and WTR46 glass (neutron data) ....................... 71

4.9 Comparison of \(T(r)\)'s of vitreous B\textsubscript{2}O\textsubscript{3} and Silica ................... 72
4.10 $T(r)$ of WTR62 glass with fit to the second peak (neutron data) ........................................ 73
4.11 $T(r)$ of Basic glass with fit to the second peak (neutron data) ........................................ 74
4.12 Schematic 2-D model of the network of the nuclear-waste glass ........................................ 76

5.1 Typical heating schedules in the preparation of the rare-earth metaphosphate glasses .......................................................... 83
5.2 Structural unit of $\nu$–$P_2O_5$ and rare-earth metaphosphate ......................................................... 89
5.3 X-ray intensity pattern normalized to the calculated form factor of La-P and La-Nd-P glasses .......................................................... 90
5.4 X-ray intensity pattern normalized to the calculated form factor of La-Pr-P and 25SmP glasses .......................................................... 91
5.5 X-ray intensity pattern normalized to the calculated form factor of La-Eu-P and La-Ho-P glasses .......................................................... 92
5.6 X-ray intensity pattern normalized to the calculated form factor of La-Tb-P glass .......................................................... 93
5.7 X-ray intensity pattern normalized to the calculated form factor of La-Er-P and La-Dy-P glasses .......................................................... 94
5.8 X-ray intensity function $i(Q)$ of La-P, La-Pr-P and La-Nd-P glasses .......................................................... 95
5.9 X-ray $Qi(Q)$ of La-P, La-Pr-P and La-Nd-P glasses .......................................................... 96
5.10 X-ray $Qi(Q)$ of 20SmP, 25SmP and La-Eu-P glasses .......................................................... 97
5.11 X-ray $Qi(Q)$ of La-Tb-P, La-Dy-P, La-Ho-P and La-Er-P glasses .......................................................... 98
5.12 Differential correlation function $D(r)$ of La-P and La-Er-P glasses (X-ray data) ....................... 99
5.13 Total correlation functions $T(r)$ of La-P and La-Pr-P glasses (X-ray data) ....................... 100
5.14 Total correlation functions $T(r)$ of 20SmP and La-Nd-P glasses (X-ray data) ....................... 101
5.15 Total correlation functions $T(r)$ of 25SmP and La-Eu-P glasses (X-ray data) ....................... 102
5.16 Total correlation functions $T(r)$ of La-Tb-P and La-Dy-P glasses (X-ray data) ....................... 103
5.17 Total correlation functions $T(r)$ of La-Ho-P and La-Er-P glasses (X-ray data) ....................... 104
5.18 Partial total correlation function $\Delta T(r)$ of La-Dy-P glass (X-ray data) ....................... 105
5.19a Comparison of $T(r)$'s of v-P$_2$O$_5$ and La-P glass (neutron data) ............................ 112
5.19 Normalized intensity $I(Q)$ of La-P and La-Ce-P glasses (neutron data) .................. 113
5.20 Normalized intensity $I(Q)$ of La-Pr-P and La-Nd-P glasses (neutron data) ............ 114
5.21 Comparison of the $S(Q)$'s of rare-earth phosphate glasses with v-P$_2$O$_5$ ............. 115
5.22 Differential correlation function $D(r)$ of phosphate glasses (neutron data) .............. 116
5.23 Fit to the total correlation function $T(r)$ of La-P glass (neutron data) .................. 117
5.24 Fit to the total correlation function $T(r)$ of La-Ce-P glass (neutron data) ............. 118
5.25 Fit to the total correlation function $T(r)$ of La-Pr-P glass (neutron data) .............. 119
5.26 Fit to the total correlation function $T(r)$ of La-Nd-P glass (neutron data) .............. 120
5.27 Radial Distribution Function $g(r)$ of La-P glass (neutron data) ............................ 121
5.27b Gaussian fits to the second peak in $T(r)$ in which $n_0(O)$ is 4 [Fig.(A)] or 6 [Fig.(B)] 121(b)
5.28 Schematic 2-D model of the network of the rare-earth phosphate glass ..................... 124
5.29 IR spectra of binary rare-earth glasses ................................................................. 126
5.30 IR spectra of rare-earth glasses containing Al$_2$O$_3$ ............................................ 127
5.31 Plot of $\chi(\alpha)_{RT}$ versus 1/T of rare-earth phosphate glasses .......................... 136
5.32 Plot of $\chi(\alpha)_{RT}$ versus 1/T of La-Er-P glass ................................................... 137
5.33 UV/Visible absorption spectra of La-P, La-Ce-P, La-Eu-P and La-Tb-P glasses .......... 139
5.34 UV/Visible absorption spectra of La-Pr-P and La-Nd-P glasses ............................... 140
5.35 UV/Visible absorption spectra of La-Ho-P and La-Er-P glasses ............................... 141
5.36 UV/Visible absorption spectra of Sm-P and La-Dy-P ............................................. 142