

List of Figures

Chapter 1

Fig. 1.1	Structure of crystalline and amorphous materials	1
Fig. 1.2	Structure of metals and metallic glass	2
Fig. 1.3	Various applications of BMGs	9

Chapter 2

Fig. 2.1	Schematic diagram of power compensated DSC	21
Fig. 2.2	Schematic diagram of heat flux DSC	22
Fig. 2.3	A picture of DSC (Shimadzu, Model DSC-50)	25
Fig. 2.4	A schematic DSC curve demonstrating the appearance of several common features	26

Chapter 3

Fig. 3.1	Different variation of ΔC_p with temperature	34
Fig. 3.2	Variation of Gibbs free energy difference (ΔG) with critical diameter (d_c)	44
Fig. 3.3	Variation of T_{rg} parameter with critical diameter (d_c)	44
Fig. 3.4	Variation of ΔT_x parameter with critical diameter (d_c)	45
Fig. 3.5	Variation of different GFA parameters with critical diameter (d_c)	45
Fig. 3.6	Gibbs free energy difference with temperature for $Mg_{48}Ni_{31}Pr_{21}$ and $Mg_{63}Ni_{22}Pr_{15}$	51
Fig. 3.7	Gibbs free energy difference with temperature for $Mg_{65}Ni_{21}Pr_{14}$ in air and argon atmosphere	51
Fig. 3.8	Entropy Difference with temperature for $Mg_{63}Ni_{22}Pr_{15}$ and $Mg_{48}Ni_{31}Pr_{21}$	53
Fig. 3.9	Entropy Difference with temperature for $Mg_{65}Ni_{21}Pr_{14}$ in air and argon atmosphere	53
Fig. 3.10	Variation of Gibbs free energy difference with temperature for $Cu_{50}Pr_{30}Ni_{10}Al_{10}$ alloy	56

Fig. 3.11	Variation of Gibbs free energy difference with temperature for $\text{Cu}_{50}\text{Pr}_{30}\text{Ni}_{10}\text{Al}_{9.9}\text{Ti}_{0.05}\text{B}_{0.05}$	56
-----------	---	----

Chapter 4

Fig. 4.1	Schematic TTT diagram	65
Fig. 4.2	Variation of ΔG with temperature for $\text{Pd}_{40}\text{Ni}_{40}\text{P}_{20}$ metallic glass	75
Fig. 4.3	Variation of ΔG with temperature for $\text{Pd}_{40}\text{Cu}_{40}\text{P}_{20}$ metallic glass	75
Fig. 4.4	Variation of ΔG with temperature for $\text{Pd}_{77.5}\text{Cu}_6\text{Si}_{16.5}$ metallic glass	76
Fig. 4.5	Variation of ΔG with temperature for $\text{Pd}_{46}\text{Cu}_{35.5}\text{P}_{18.5}$ metallic glass	76
Fig. 4.6	Variation of ΔG with temperature for $\text{Pd}_{42.5}\text{Cu}_{30}\text{Ni}_{7.5}\text{P}_{20}$ metallic glass	77
Fig. 4.7	Calculated TTT curves for $\text{Pd}_{40}\text{Ni}_{40}\text{P}_{20}$ metallic glass by different expression of ΔG	82
Fig. 4.8	Calculated TTT curves for $\text{Pd}_{40}\text{Cu}_{40}\text{P}_{20}$ metallic glass by different expression of ΔG	83
Fig. 4.9	Calculated TTT curves for $\text{Pd}_{77.5}\text{Cu}_6\text{Si}_{16.5}$ metallic glass by different expression of ΔG	83
Fig. 4.10	Calculated TTT curves for $\text{Pd}_{46}\text{Cu}_{35.5}\text{P}_{18.5}$ metallic glass by different expression of ΔG	84
Fig. 4.11	Calculated TTT curves for $\text{Pd}_{42.5}\text{Cu}_{30}\text{Ni}_{7.5}\text{P}_{20}$ metallic glass by different expression of ΔG	84
Fig. 4.12	Variation of Gibbs free energy difference with temperature for $\text{Cu}_{50}\text{Zr}_{50}$	87
Fig. 4.13	Variation of Gibbs free energy difference with temperature for $\text{Cu}_{54}\text{Zr}_{46}$	88
Fig. 4.14	TTT curves for $\text{Cu}_{50}\text{Zr}_{50}$	89
Fig. 4.15	TTT curves for $\text{Cu}_{54}\text{Zr}_{46}$	89

Chapter 5

Fig. 5.1	Energy Dispersive X-ray analysis (EDX) of $\text{Zr}_{52}\text{Cu}_{18}\text{Ni}_{14}\text{Al}_{10}\text{Ti}_6$ amorphous ribbons	111
Fig. 5.2	DSC Thermogram for $\text{Zr}_{52}\text{Cu}_{18}\text{Ni}_{14}\text{Al}_{10}\text{Ti}_6$	112

Fig. 5.3	Variation of Crystallized fraction with temperature at different heating rate: symbols represent experimental points and solid lines show the least square fitted curve by eq. (5.14)	114
Fig. 5.4	Normalized $y(\alpha)$ and $z(\alpha)$ with crystallized fraction α for different heating rates	115
Fig. 5.5	Master plot at different heating rates; (▲▲) experimental, (—) JMA, (....) S-B: @5°C/min	116
Fig. 5.6	Master plot at different heating rates; (▲▲) experimental, (—) JMA, (....) S-B: @10°C/min	117
Fig. 5.7	Master plot at different heating rates; (▲▲) experimental, (—) JMA, (....) S-B: @15°C/min	117
Fig. 5.8	Master plot at different heating rates; (▲▲) experimental, (—) JMA, (....) S-B: @20°C/min	118
Fig. 5.9	Normalized heat flow curves at different heating rates @5°C/min	119
Fig. 5.10	Normalized heat flow curves at different heating rates @10°C/min	119
Fig. 5.11	Normalized heat flow curves at different heating rates @15°C/min	120
Fig. 5.12	Normalized heat flow curves at different heating rates @20°C/min	120
Fig. 5.13	KAS plot for $\alpha = 0.7$	122
Fig. 5.14	Kissinger plot	123
Fig. 5.15	Augis & Bennett's plot	123
Fig. 5.16	Boswell plot	124
Fig. 5.17	OFW plot for $\alpha = 0.7$	124
Fig. 5.18	Ozawa plot	125
Fig. 5.19	Friedman plot for $\alpha = 0.7$	126
Fig. 5.20	Gao & Wang plot	127
Fig. 5.21	Local activation energies (E_a) at different α from different methods	128
Fig. 5.22	Plot of $\ln[-\ln(1 - \alpha)]$ vs. $\ln \beta$	130
Fig. 5.23	Plot of $\ln[-\ln(1 - \alpha)]$ vs. $1000/T$ for different heating rates	130
Fig. 5.24	Variation of local Avrami exponent with crystallized fraction	131
Fig. 5.25	Modified Kissinger plot	132
Fig. 5.26	Relationship between temperature and $\ln \beta$ for T_{x1} , T_{x2} , T_{p1} and T_{p2}	133

List of Tables

Chapter 3

Table 3.1	Thermodynamic parameter ΔG by different theoretical expressions	39
Table 3.2	Thermodynamic parameter ΔG for different metallic glasses	41
Table 3.3	Different GFA parameters	42
Table 3.4	Different GFA criteria for Mg-Ni-Pr based metallic glasses	49
Table 3.5	Thermodynamic parameters of Mg-Ni-Pr based metallic glasses	50
Table 3.6	Gibbs free energy difference (ΔG) and GFA parameters for Cu-Pr based metallic glasses	55

Chapter 4

Table 4.1	$\Delta G (T_g)$ values for various Pd-based alloys by different methods	73
Table 4.2	Calculated mixing enthalpies and entropies, and critical sizes (Z_c) of Pd-based metallic glasses	79
Table 4.3	Critical cooling rate (R_c) values for various Pd-based alloys by different methods	81
Table 4.4	Critical cooling rate R_c and d_{max} for different Cu-Zr metallic systems	91

Chapter 5

Table 5.1	Values of Avrami (growth) exponent (n), pre-exponential factor (k_0) and activation energy (E) obtained by least square fitting of fractional crystallization data for second crystallization peak	115
Table 5.2	Local activation energies (E_a) at different degrees of conversions, α for different methods	122
Table 5.3	Activation energy (E) and pre-exponential factor (k_0) for different methods	125
Table 5.4	Values of Avrami exponent (n) and dimensionality (m) by Matusita and Sakka method	129
Table 5.5	Values of A & B for $Zr_{52}Cu_{18}Ni_{14}Al_{10}Ti_6$ metallic glass	133

List of Publications

❖ Papers published in international refereed journals

1. *Study of glass forming ability parameters of Mg-Ni-Pr based metallic glasses*
Sonal R Prajapati , Ashmi T. Patel, Arun Pratap
 International journal of modern physics: Conference series, 22: 327-331 Dec.2013
2. *A thermodynamic approach towards glass-forming ability of amorphous metallic alloys*
Sonal R Prajapati, Supriya Kasyap, Arun Pratap
 Bulletin of Materials Science, 38(7): 1693-1698, December 2015
3. *Non-isothermal crystallization kinetics of $Zr_{52}Cu_{18}Ni_{14}Al_{10}Ti_6$ metallic glass*
Sonal R Prajapati, Supriya Kasyap, Ashmi T. Patel, Arun Pratap
 Journal of Thermal Analysis and Calorimetry, 124(1): 21-33, April 2016
4. *Glass Effect of driving force of crystallization on critical cooling rate for Pd based metallic glasses*
Sonal R. Prajapati, Supriya Kasyap, Arun Pratap,
 [Accepted for publication in Journal of Thermal Analysis and Calorimetry]

❖ Paper presented at Conferences

1. *Study of glass forming ability parameters of Mg-Ni-Pr based metallic glasses*
Sonal R Prajapati , Ashmi T. Patel, Arun Pratap
 International conference on Ceramics (ICC-2012) – Bikaner, Rajasthan
2. *Glass Forming Ability and Thermal Stability of Cu-Pr Based Metallic Alloys*
Sonal R Prajapati, Arun Pratap
 7th National Conference on thermophysical Properties
 (NCTP-2013) – Kanpur, U. P.
3. *A thermodynamic approach towards glass-forming ability of amorphous metallic alloys*
Sonal R Prajapati, Supriya Kasyap, Arun Pratap
 International Conference in Asia-2013 (IUMRS-ICA-2013) – Bangalore.

4. *Glass forming ability of Au based metallic glass*
Sonal R. Prajapati, Supriya Kasyap, Arun Pratap
 National Conference on Perspectives of Physics in Multi-disciplinary Research (NCPJ-14) – Jaipur, Rajasthan
5. *Glass forming ability of Au based metallic glass*
Sonal R. Prajapati, Supriya Kasyap, Arun Pratap
 National Conference on Advanced Functional Materials & their Applications (AFMA-2015) – Ajmer, Rajasthan

❖ Other publications

1. *Kinetics of Phase Transformation in Metallic Glasses*
 Arun Pratap, Supriya Kasyap, **Sonal R. Prajapati**, Ashmi T. Patel
 ITAS Bulletin, 6 (1): 37-49, June 2013
2. *Heating Rate and Composition Dependence of Crystallization Temperature of Cu-based Metallic Glasses*
 Supriya Kasyap, **Sonal Prajapati**, Arun Pratap
 Advanced Materials Research,
3. *Glass Forming Ability of Zr-based Amorphous Alloys*
 Supriya Kasyap, **Sonal R. Prajapati**, Arun Pratap
 [Accepted for publication in Advanced Science Letters]
4. *Thermodynamic behavior of $Au_{49}Ag_{5.5}Pd_{2.3}Cu_{26.9}Si_{16.3}$ metallic glass in under-cooled region*
 Supriya Kasyap, **Sonal R. Prajapati**, Arun Pratap
 [Submitted to International Journal of Thermophysics]
5. *Bio-corrosion studies of $Co_{66}Si_{12}B_{16}Fe_4Mo_2$ metallic glass*
 Supriya Kasyap, **Sonal R. Prajapati**, Arun Pratap
 [Submitted to Advanced Electrochemistry]