Annexure – VIII

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF SENDING THE

FINAL REPORT OF THE WORK DONE ON THE PROJECT

1. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR : Dr T Shanker Rao
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2. NAME AND ADDRESS OF THE INSTITUTION: Narmada College of Science and Commerce,Zadeshwar Bharuch 392011 (Gujarat)

3. UGC APPROVAL NO. AND DATE : 47-773/13(WRO) dated 20/03/2014

4. DATE OF IMPLEMENTATION : 05/05/2014

5. TENURE OF THE PROJECT : Two years (Extended for one year)

6. TOTAL GRANT ALLOCATED :Rs 155000/-

7. TOTAL GRANT RECEIVED : Rs 122500/-

8. FINAL EXPENDITURE :Rs.97934 (Rs Ninety seven thousand nine hundred thirty four only)

9. TITLE OF THE PROJECT : Electrical Resistivity measurement and crystallization behavior of Cobalt base metallic glasses

10. OBJECTIVES OF THE PROJECT:

1. Checking the Amorphous nature by X-ray diffraction (XRD) method.
2. Measurement of electrical resistivity from room temperature (RT) to 1000 ^{0}C .
3. Pin pointing the peak crystallization temperatre(T_p) and estimation of activation energy for crystallization(E_c) using DSC experimental data.
4. Study of variation of (i) T_p with heating rate(β) (ii) E_c with fractional crystallization (α)
5. Entire project work will be summarized and conclusions will be drawn. Later papers will be communicated to the Journals/International conferences

11. WHETHER OBJECTIVES WERE ACHIEVED: All the objectives of the project were achieved except the study of crystallization kinetics using resistivity set up because the set up received late. The study is going on.

12. ACHIEVEMENTS FROM THE PROJECT: Thermal stability of the two samples of metallic glasses were successfully studied.

13. SUMMARY OF THE FINDINGS: Separate sheet is attached

14. CONTRIBUTION TO THE SOCIETY: If our work is patented then contribution to the society can be thought.

15. WHETHER ANY PH.D. ENROLLED/PRODUCED: Not applicable.
OUT OF THE PROJECT

16. NO. OF PUBLICATIONS OUT OF THE PROJECT: Four papers are published in the Journals and two papers are presented in the international conferences.

(Principal Investigator) (Principal)

Dr T Shanker Rao Dr A K Singh

SUMMARY OF THE FINDINGS

The objective of this project is to understand the crystallization kinetics through DSC(DifferentialScanning Calorimetry) and electrical resistivity measurements in Cobalt based $Co_{66}Si_{15}B_{14}Fe_4Ni_1$, $Co_{69}Si_{12}B_{12}Fe_4Mo_2Ni_1$, $Co_{70}Si_{23}B_{23}Mn_5Fe_2Mo_2$ and $Co_{78}Si_9Mo_5Fe_4B_2Nb_2$ metallic glasses. Unfortunately for these samples shipment to India was restricted from UK company Goodfrllow. So, the other samples 2714A ($Co_{65}Si_{15}B_{14}Fe_4Ni_2$) and 2605S3A ($Fe_{77}B_{16}Si_5Cr_2$) metallic glasses procured from Metglas as a gift.

Summary

Metallic glass 2714A ($Co_{65}Si_{15}B_{14}Fe_4Ni_2$)

(1) The high value of activation energy of crystallization indicates that the studied amorphous metallic glass is more thermally stable.
(2) We can also conclude that more fragile the glass forming metallic glass is, larger the activation energy of crystallization.
(3) Fragility index, m is calculated from the E_x, the activation energy of onset crystallization. The value is nearly 48 and according to the Angell's scheme indicates the intermediate strong glass.
(4) The fragility index, m shows nearly constant by all the utilized methods at heating rate 4 K/min i.e., at T_x=814.46 K.
(5) The fragility index, m decreases with T_x and T_x / E_x in metallic glasses(Figs 5 and 6). Based on the plots of Figs 5 and 6 the authors proposes a relationship between T_x and E_x : m α E_x / T_x The relation m α E_g has been recently verified by Abu-Sehyl.

The relation m α $(E_x/T_x)^{-1}$ shows strong dependence in polymers.This behavior is attributed to the large molecular weight of the polymers.

Metallic glass $Fe_{77}B_{16}Si_5Cr_2$(2605S3A)

(1).The model free isoconversional methods proposed by KAS and OFW gives E which are dependent on α. The values of E determined from KAS and OFW are very close to each other for both the peaks I and II and also fall near to the non-linear isoconversional method proposed by Vyazovkin and Wight.

(2). The results of Li-Tang are deviating from consistency for both the peaks I and II in the entire range of α. This is probably due to the absence of approximations involved in the derivation.

(3).The values of E from FR method clearly showed no systematic trend for peak I and II. This discrepancy may be due to the reason that the FR method uses the point values of the overall reaction rate while the integral isoconversional methods use the integrals, which describe the history of the system in the range 0.1 to 0.9.

(4). The model fitting isokinetic methods, on the other hand gives single value of E. The CR method has been utilized to evaluate E and $g(\alpha)$ and gave E = 441 kJ/mol and $g(\alpha)=(-\ln(1-\alpha))^{1/4}$ for peak I and E = 362.3 kJ/mol and $g(\alpha) = (-\ln(1-\alpha))^{1/5}$ for peak II.

(5).The IKP method is also used in conjunction with the CR method to determine E and A values for peak I and II and the E and A values to be ≈ 415 kJ/mol , $4.3X\ 10^{22}\ sec^{-1}$ and 340 kJ/mol , $5.7x10^{16}\ sec^{-1}$.

(6).The evaluated E values from CR and IKP methods are consistent with the values determined from isoconversional KAS and OFW methods and are 434 kJ/mol and 373 kJ/mol for peak I and II.

(7). Based on the studies of isoconversional and isokinetic methods it is evident that the isoconversional methods gave α dependent E values which bears the signature of the crystallization mechanism. On the other side isokinetic methods gave single valued E and showed only one mechanism (reaction model) throughout the crystallization process for Fe-based metallic glass 2605S3A.

(8).The present investigation showed that, even though diverse approaches (isoconversional and isokinetic) are used, the results were consistent and complimentary to each other and the same trend is seen in other Co and Fe based metallic glasses.

(Principal Investigator) (Principal)

Dr T Shanker Rao Dr A K Singh