Electronic Supplementary Material (ESI) for Soft Matter.

Supporting Information for

Experimental evidence for β-relaxation and its structural origin in ZIF-62 glass

Containing:

Materials and Methods

Materials

The metallic glasses were prepared by the arc-melting technique. Master-alloy ingots were first prepared using a mixture of high purity (99.99%) metal elements in an argon atmosphere. The master alloys were re-melted at least five times to ensure the chemical homogemeity of the model alloys and then suction casting into a copper mould with an internal cylindrical cavity of diameter up to 3 mm. The amorphous phase change materials were produced by dc magnetron sputtering and the Se glass was purchased from Aladdin. The more detailed information of these materials can be obtained in our previous works.[1-5]

Supplementary Figure 1

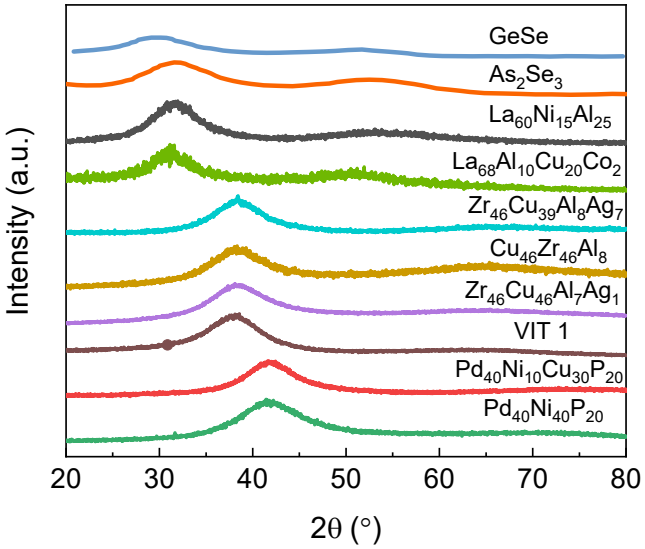

Figure S1. The XRD patterns of different glasses.

Supplementary Figure 2

Figure S2 Optical photograph of (a) ZIF-62 crystal; (b) Powder ZIF-62 glass; (c) Bulk ZIF-62 glass.

Supplementary Figure 3

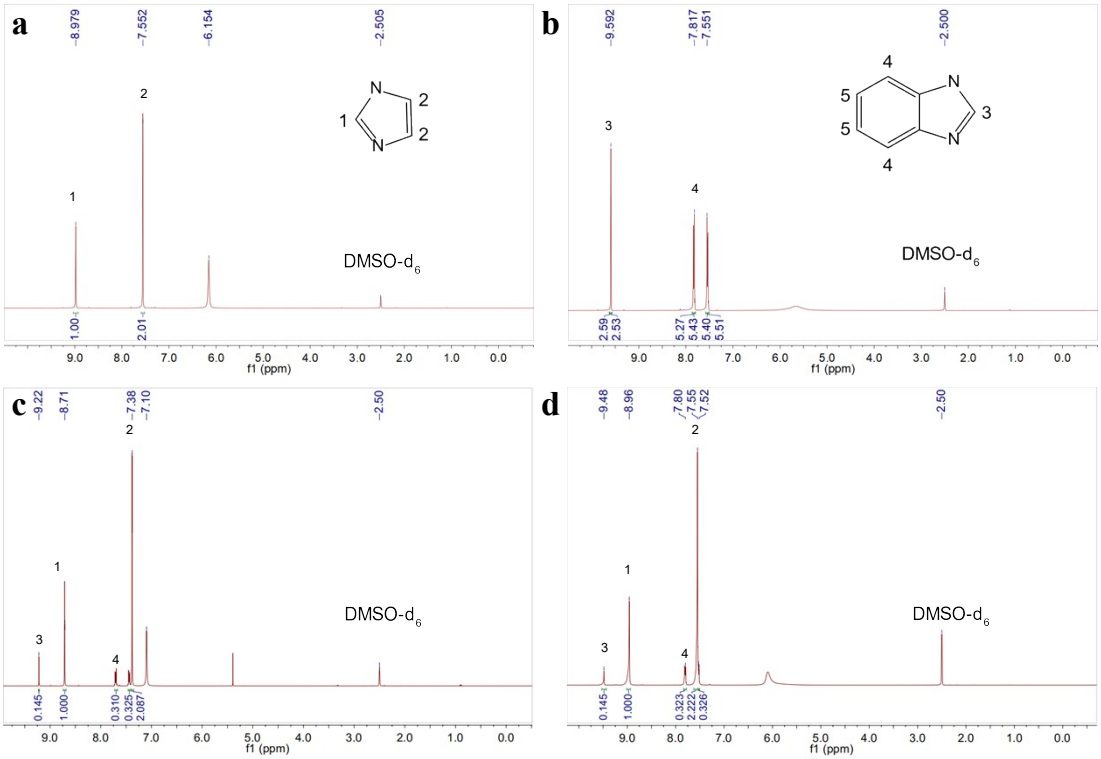

Figure S3. **The characterization of linker ratios of ZIF-62.** ^{1}H NMR spectra of (a) Im. (b) bIm. (c) ZIF-62 crystal and its (d) Glass.

Supplementary Figure 4

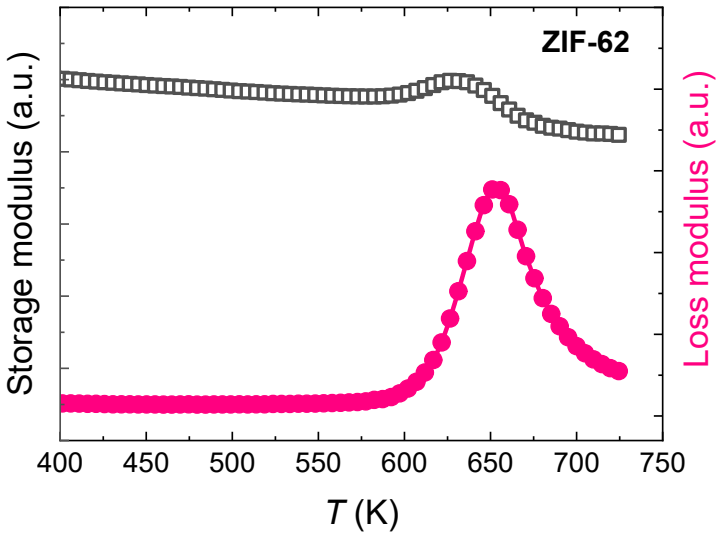

Figure S4. The temperature dependence storage modulus E' and loss modulus E'' curves of powder ZIF-62 glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 5

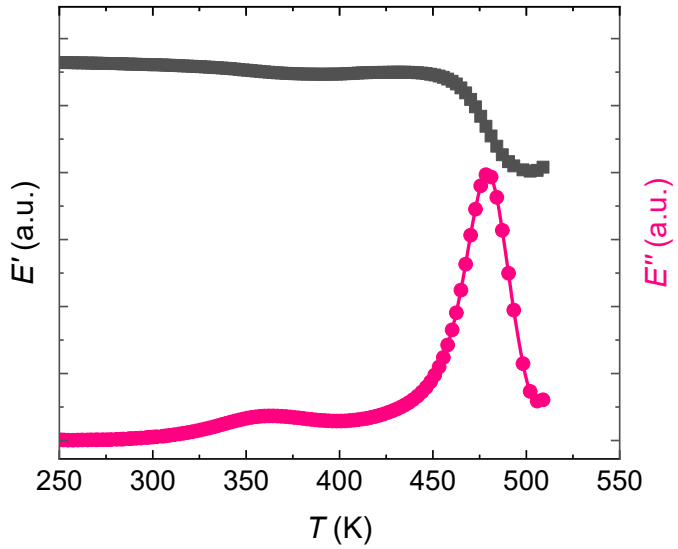

Figure S5. The temperature dependence storage modulus E' and loss modulus E'' curves of $La_{60}Ni_{15}Al_{25}$ bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 6

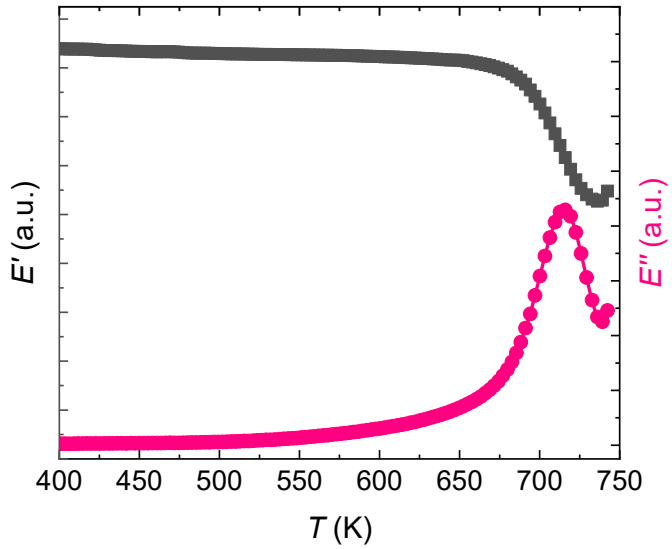

Figure S6. The temperature dependence storage modulus E' and loss modulus E'' curves of $Zr_{46}Cu_{46}Al_7Gd_1$ bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 7

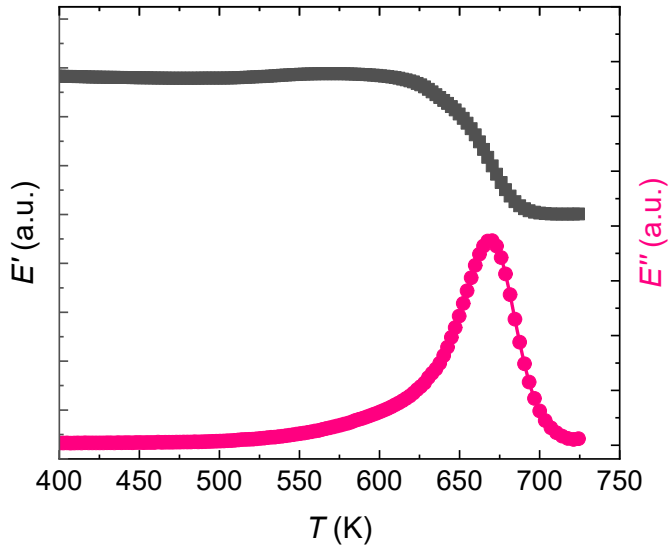

Figure S7. The temperature dependence storage modulus E' and loss modulus E'' curves of VIT1 bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 8

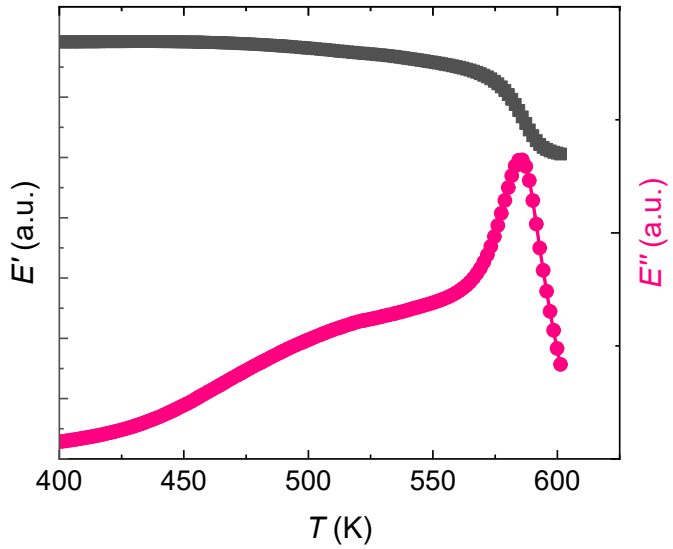

Figure S8. The temperature dependence storage modulus E' and loss modulus E'' curves of $Pd_{40}Ni_{10}Cu_{30}P_{20}$ bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 9

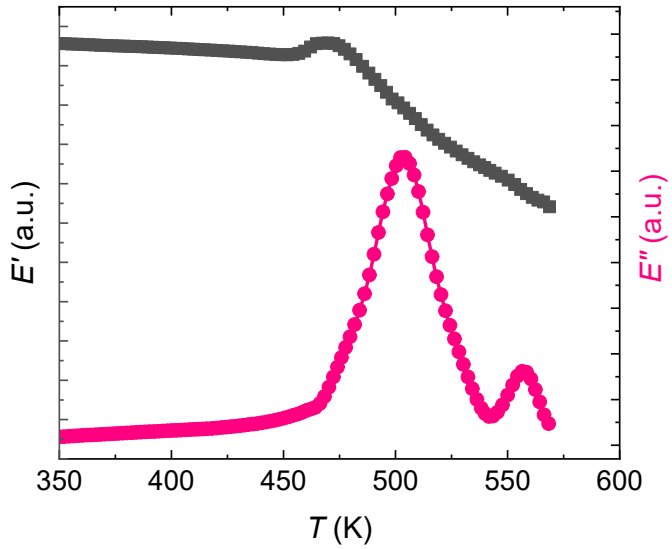

Figure S9. The temperature dependence storage modulus E' and loss modulus E'' curves of As_2Se_3 bulk glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 10

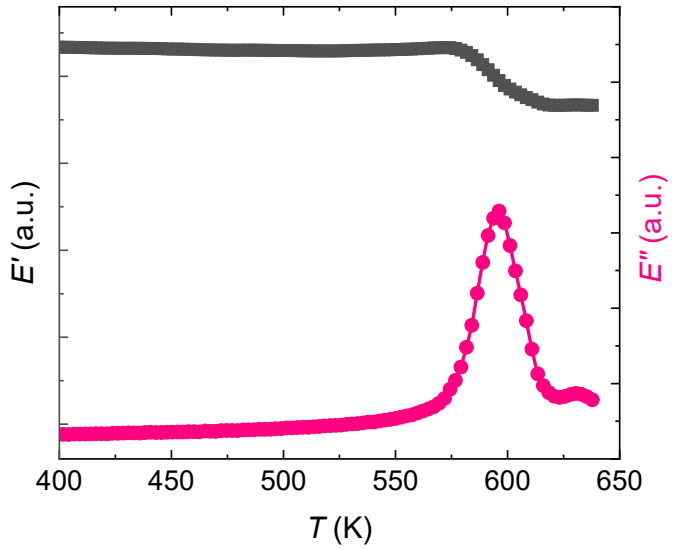

Figure S10. The temperature dependence storage modulus E' and loss modulus E'' curves of GeSe powder glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 11

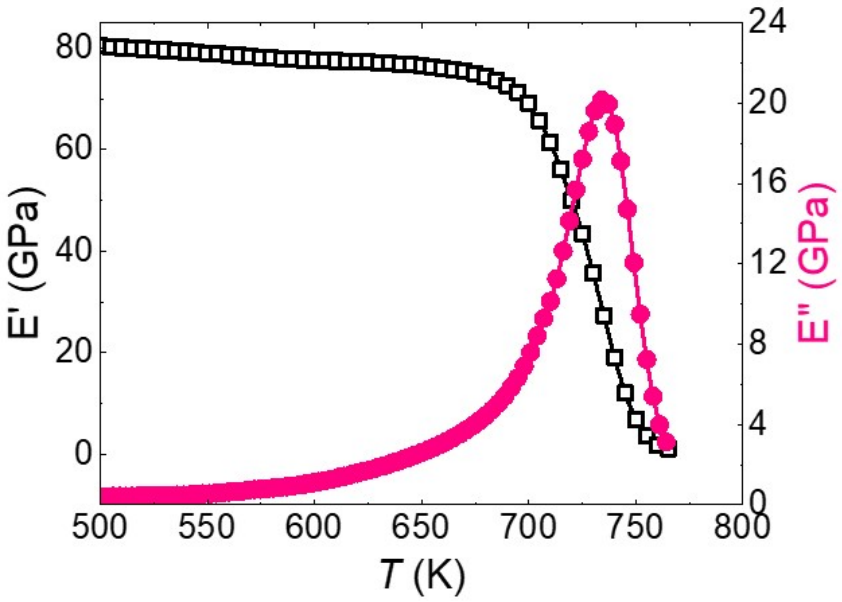

Figure S11. The temperature dependence storage modulus *E′* and loss modulus *E″* curves of $Zr_{46}Cu_{39}Al_8Ag_7$ bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 12

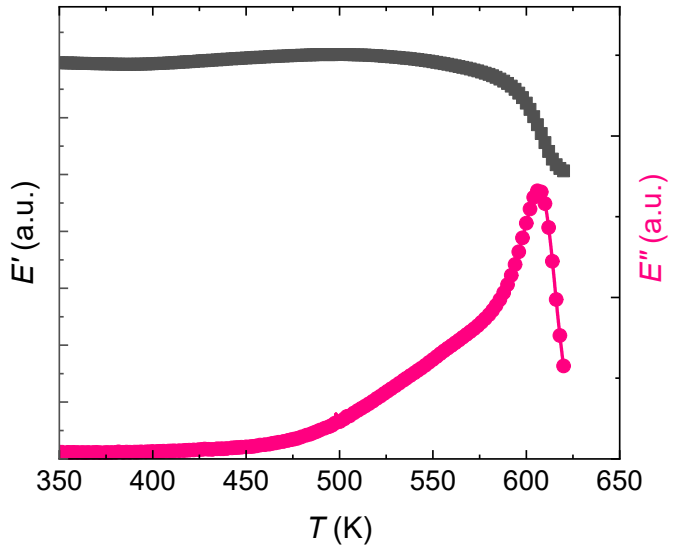

Figure S12. The temperature dependence storage modulus E' and loss modulus E'' curves of $Pd_{40}Ni_{40}P_{20}$ bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 13

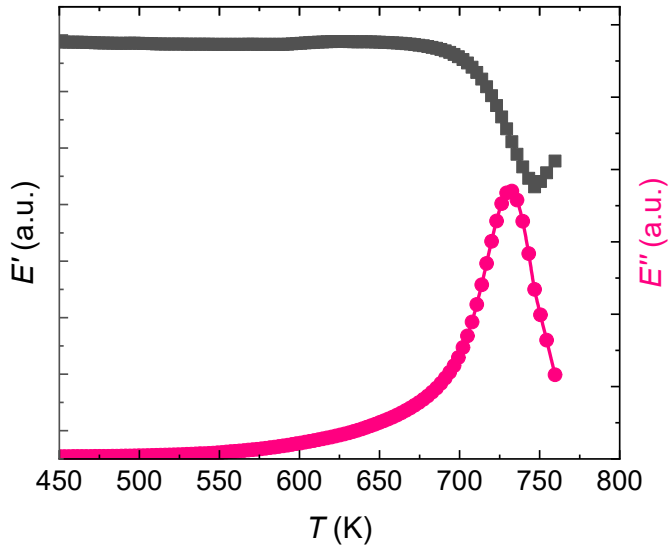

Figure S13. The temperature dependence storage modulus E' and loss modulus E'' curves of $Cu_{46}Zr_{46}Al_8$ bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 14

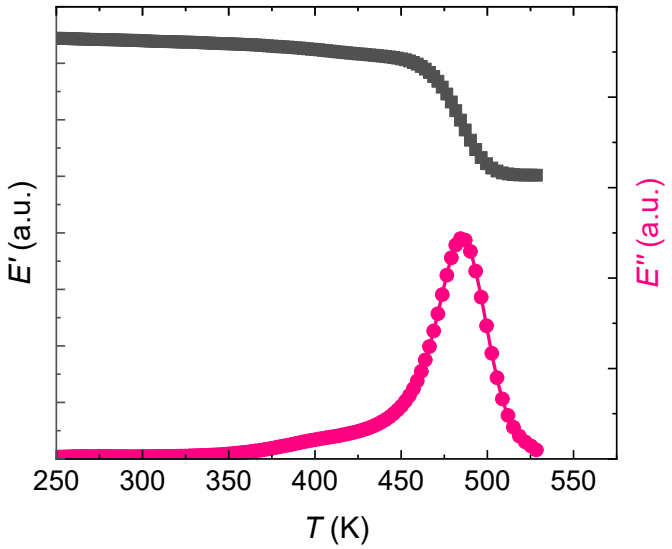

Figure S14. The temperature dependence storage modulus E' and loss modulus E'' curves of $La_{68}Al_{10}Cu_{20}Co_2$ bulk metallic glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

Supplementary Figure 15

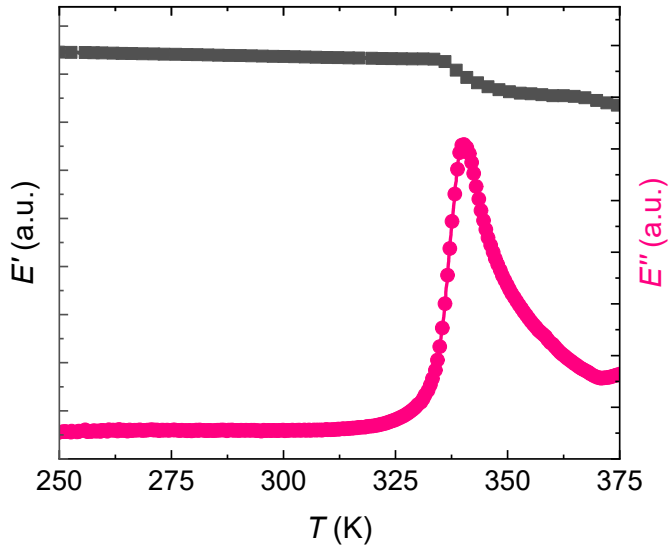

Figure S15. The temperature dependence storage modulus E' and loss modulus E'' curves of Se glass. The heating rate is 3 K/min and testing frequency is 1 Hz.

REFERENCES

[1] Y. Sun, S.-X. Peng, Q. Yang, F. Zhang, M.-H. Yang, C.-Z. Wang, K.-M. Ho, and H.-B. Yu, "Predicting Complex Relaxation Processes in Metallic Glass," Phys. Rev. Lett. **123**, 105701 (2019).

[2] S.-X. Peng, Y. Cheng, J. Pries, S. Wei, H.-B. Yu, and M. Wuttig, "Uncovering β-relaxations in amorphous phase-change materials," Sci. Adv. **6**, eaay6726 (2020).

[3] S.-X. Peng, C. Zhang, C. Yang, R. Li, T. Zhang, L. Liu, H.-B. Yu and K. Samwer, "Anomalous nonlinear damping in metallic glasses: Signature of elasticity breakdown," J. Chem. Phys. **150**, 111104 (2019).

[4] Q. Yang, S.-X. Peng, Z. Wang and H.-B. Yu, "Shadow glass transition as a thermodynamic signature of β relaxation in hyper-quenched metallic glasses," Natl. Sci. Rev. **7**, 1896-1905 (2020).

[5] E.-Y. Chen, S.-X. Peng, L. Peng, M. D. Michiel, G. B.M. Vaughan, Y. Yu, H.-B. Yu, B. Ruta, S. Wei, L. Liu, "Glass-forming ability correlated with the liquid-liquid transition in $Pd_{42.5}Ni_{42.5}P_{15}$ alloy," Scripta Mater. **193**, 117-121 (2021).