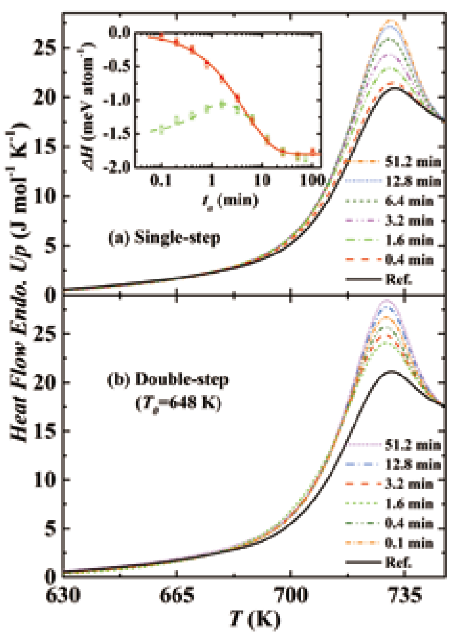
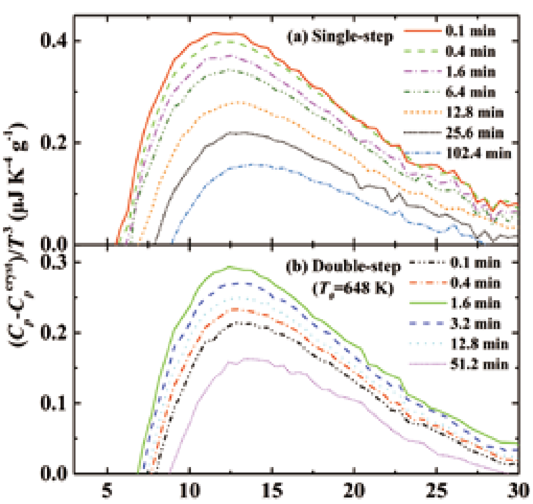
Memory Effect Unveils the Correlation between Boson Peak and Structural Relaxation

Glass is a nonequilibrium state that continually relaxes toward a metastable equilibrium state by structural rearrangements. What is mysterious is that its past state is always memorized, *viz.*, showing memory effect. Glass exhibits disordered structure and anomalous atomic vibration as compared to ordered crystals, and this anomaly is termed as a boson peak. These two features, both are central to the understanding of glass, are generally investigated separately.

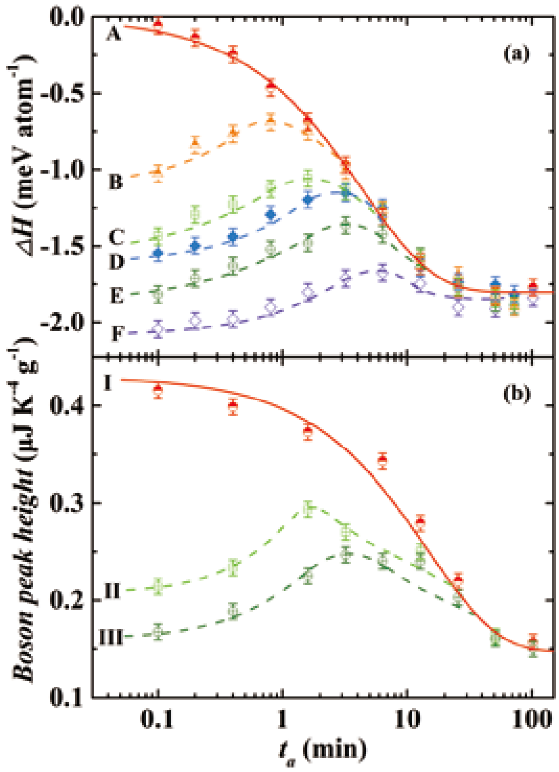
Recently LUO Peng *et al.* of Prof. WANG Weihua's group from the Institute of Physics (IOP), Chinese Academy of Sciences made new efforts to investigate whether the atomic vibrational state can be memorized just like the structural arrangement in a metallic glass. Interestingly, they found that boson peak and structural relaxation evolve in line with each other and both exhibit history-dependent behaviors of memory effect. By this experimental observation they proposed that the slow structural rearrangement by atomic motion and the fast atomic vibrational state are correlated with each other, presenting a clearer picture for further understanding the two dynamical behaviors in glass and providing robust evidence for discriminating between the different existing theoretical models.



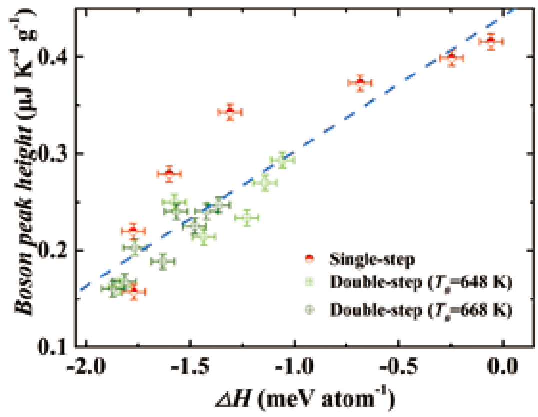
Enthalpy recovery during (a) single-step isothermal aging and (b) double-step isothermal aging. The nonmonotonic evolution of enthalpy reveals the memory effect. (Image by IOP)



Boson heat capacity peak during (a) single- and (b) double-step isothermal aging. The nonmonotonic evolution of boson peak suggests a memory effect. (Image by IOP)



The boson peak strength and the relative enthalpy change follow analogous evolution under the same thermal protocol. (Image by IOP)



The boson peak strength and the relative enthalpy change show approximately a linear relationship. (Image by IOP)

Supported by the National Natural Science Foundation of China (Grant No. 51271195), the National Basic Research Program ("973" Program) sponsored by the Chinese Ministry of Science and Technology 973 Program (Grant No. 2015CB856800) and the Chinese Academy of Sciences, the study entitled "Memory Effect Manifested by a Boson Peak in Metallic Glass" was published on *Physical Review Letters* http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.116.175901