

Scopigno *et al.* Reply: The preceding Comment by Courtens, Foret, Rufflé, and Vacher (CFRV) [1] addresses one of the outcomes of our Letter [2], i.e., that the correlation between the energy of the Ioffe-Regel (IR) crossover (E_{IR}) and the boson peak (BP) energy (E_{BP}), proposed in [3], is not applicable to the metallic glass $Ni_{33}Zr_{67}$. To rebut this conclusion, CFRV raise two objections: (i) the fragility index, m , for $Ni_{33}Zr_{67}$ glass is much larger than we estimated from computer simulations [4] and (ii) the observed broadening of the excitations (Γ) is caused by “diffuse umklapp scattering” rather than by acoustic damping, which would imply an incorrect determination of E_{IR} .

In this context, the first objection is not relevant. $Ni_{33}Zr_{67}$ has $E_{BP} \approx 3$ meV [2] and the correlation proposed in [3] (which predicts $E_{IR} \approx E_{BP}$) would imply a crossover at $Q = 1$ nm⁻¹, while the frequency of the acoustic excitation we measure (Ω) clearly satisfies the condition $\Gamma < \frac{\Omega}{\pi}$ up to $Q = 14$ nm⁻¹. The proposed correlation, therefore, is violated in $Ni_{33}Zr_{67}$ independently on its fragility value. In the conclusions of their Comment, however, CFRV promptly warn the reader about the restricted validity of this correlation, which should only hold when the BP contains a “sufficient” amount of excess of modes. In this respect, the authors are misleadingly equating glasses with a sufficient amount of excess modes with “sufficiently” strong glasses. In any event, the fragility claimed for $Ni_{33}Zr_{67}$ by CFRV in [1] ($m \approx 90$) is similar to that of half of the systems presented by the same authors in [3] like OTP ($m \approx 81$), selenium ($m \approx 87$), propylene carbonate ($m \approx 104$), ethanol ($m \approx 60$), polybutadiene ($m \approx 60$), and some of these systems (e.g., selenium) have a BP as weak as that of $Ni_{33}Zr_{67}$. The reasons why these latter systems should be used to support the validity of the correlation, while $Ni_{33}Zr_{67}$ is not allowed to disprove it, are not evident at all.

Concerning the fragility value claimed by CFRV for $Ni_{33}Zr_{67}$ (which, once more, is not relevant to explain why this system does not fit the picture [3]), the authors did not probably realize that the reference they use [5] is relative to a different alloy, namely $Ni_{60}Zr_{40}$, which has a considerably smaller Zr content and will therefore be more fragile than $Ni_{33}Zr_{67}$. Moreover, their estimate stems from an *indirect* correlation between fragility and “Inverse heating rate as function of onset temperature of the glass transition normalized to the onset temperature of the glass transition measured with a rate of 0.0167 K/min” [see Fig. (10) in [5]]. Conversely, the fragility value we report is *directly determined* from standard Vogel Fulcher analysis of the only available viscosity data for $Ni_{33}Zr_{67}$ [4] and is consistent with *indirect inference* from vibrational properties [6].

As far as the existence of an IR crossover is concerned, $Ni_{33}Zr_{67}$ appears to be an ideal system to address this issue: first, the acoustic mode is so narrow and well separated by the elastic contribution that the determination of its position and linewidth should not rely upon a specific fitting

model and could, in principle, be done by a ruler. Second, no important contribution to the dynamic structure factor other than from the acoustic mode is expected on the basis of molecular dynamics simulation [7,8]. The Comment warns about a possible contribution from diffuse umklapp scattering to the line width. Fig. 2 of Ref. [7] and especially in Fig. 5 of Ref. [9], however, show that the contribution from diffuse umklapp scattering is very small still at $0.6 Q_p$ (less than 10%) and almost zero at $0.53 Q_p$ (our case). A significant contribution from optic modes can be basically excluded on the basis of the computer simulations of Hafner and Krajci, who find optic modes only in the Ni-rich samples [8], while for Zr-rich samples they find the Ni atoms vibrate like impurity atoms. Moreover, we have shown [2] that the contribution from S_{cc} to the measured $S(Q, \omega)$ is down by a factor of 10 compared to the contribution of S_{nn} . Concerning these impurity excitations from Ni atoms, the neutron weighted spectral functions for the Zr-rich sample in Fig. 6 of [8] show a dispersionless mode near 30 meV at $0.65 Q_p$. Neutron scattering from 33% Ni atoms is a factor of 1.5 more intense than that from 67% Zr, and therefore one may see a contribution from the Ni atoms at $0.65 Q_p$. In the case of x rays, however, the 33% Ni atoms scatter 4 times less than the 67% Zr atoms and therefore a sizable contribution from the Ni vibrations would be quite unexpected at $0.53 Q_p$. In view of that we believe that significant contributions from these three kinds of vibrations are unlikely to be observed in our experiment.

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