Reply to "Comment on 'Role of liquid compressional viscosity in the dynamics of a sonoluminescing bubble' "

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In reply to the comment of Lu and An on our publication paper [Phys. Rev. E **70**, 016304 (2004)], we show that the consideration of water vapor exchange at the bubble interface is essential for obtaining our results and the adiabatic model is too simple to produce the differences. Moreover, in spite of smallness of the compressional viscosity term at the collapse, the illustrated differences are reasonable due to the strong nonlinearity of the bubble dynamics at the collapse and its sensitivity to even small perturbations. We emphasize on the correctness of our calculation results and our simulation programs are now available on the web.

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Lu and An [1] provided a simple adiabatic analysis to criticize the validity of our computation results in Ref. [2]. Due to smallness of the compressional viscosity (CV) term at the collapse, they concluded the illustrated effects in Ref. [2] are not reasonable. In reply, we should mention although scaling analysis shows the order of magnitude of the CV term is two orders smaller than the prevailing compressibility term, $(R/\rho C)dP_l/dt$, at the sonoluminescence time, but this is not a guarantee that the addition of the CV term cannot produce any distinguishable effect after the collapse. The point is that the bubble motion at the collapse is highly nonlinear and therefore very sensitive to even small perturbations. This sensitivity is so strong that the addition of a small perturbation at the collapse can produce noticeable differences during the rebounds. Since there is no problem with the derivation of the CV term, its strong effects after the collapse are reasonable with regard to the strong nonlinearity of the bubble equations at the collapse.

The influences of the addition of the CV term to the bubble boundary equation for both adiabatic and hydrochemical models have been shown in Fig. 1. There is no distinguishable difference between the two curves for the adiabatic model, as previously mentioned in our other work [3]. When the adiabatic model is replaced by a model including effect of water vapor exchange at the bubble wall, the difference will appear. This figure shows the sensitivity of the bubble dynamics at the collapse strongly depends on the model of gas evolution inside the bubble. Due to the negligence of water vapor exchange at the bubble wall in the adiabatic model, the value of gas pressure is underestimated more than one order of magnitude and the damping effect of compressional viscosity is not revealed. We emphasize to this point that the consideration of water vapor exchange between the bubble and the liquid is essential for obtaining the damping role of compressional viscosity and this effect is independent on consideration of chemical reactions [4].

About the recomputation assert of Lu and An, we point out their results (with and without the CV term) look exactly like our work with the CV term in Fig. 1. This can indicate there is a problem in their recomputation. If there was any problem in our work to obtain the effect of the CV term, they should have reproduced at least our result without the CV term not the result with the CV term. In order to allow a judgment of the validity of their recomputation, we have put our simulation programs on the web [5].

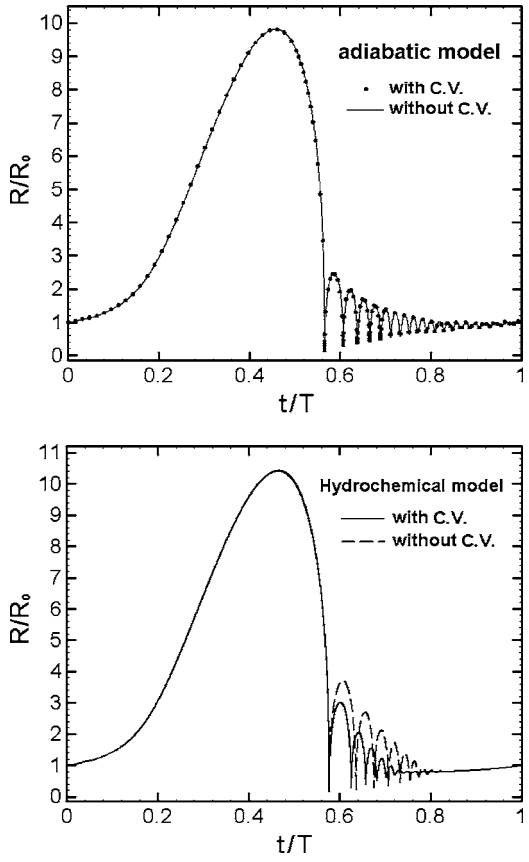

FIG. 1. Effects of introducing the compressional viscosity term to the bubble boundary equation for the adiabatic and the hydrochemical models. The constants and parameters are the same as in Fig. 1 of Ref. [2].

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[3] A. Moshaii, R. Sadighi-Bonabi, M. Taeibi-Rahni, and M. Daemi, Chin. Phys. Lett. **21**, 356 (2004).
[4] http://arxiv.org/abs/physics/0309080
[5] http://physics.ipm.ac.ir/data/programs.zip