Bonamy and Ravi-Chandar Reply: In their comment, Sharon *et al.* [1] raise two basic questions about the interpretations provided in our Letter [2].

The second series of experiments reported in [2] was designed to examine persistence characteristics of perturbations introduced on propagating cracks; shear waves propagating normal to the fracture plane, with polarization direction parallel to the crack front perturbed the crack for a short duration but were found to not leave a persistent trail. Sharon *et al.* claim that this perturbation does not break the translational invariance of the front. However, in experiments the nominal fracture plane is almost always at an angle to the propagation direction of the shear wave (by as much as 20 degrees) and hence symmetry is inevitably broken. The mode III loading introduced by the shear wave can only perturb the crack out of its original plane; if symmetry is not broken, the crack surface should remain planar. The very fact that the interaction between the shear wave and the crack front leaves a detectable surface undulation (Fig. 5a of [2]), argues against their claim. If the misalignment between the wave propagation direction and the fracture plane is ten degrees, then the shear wave with a wavelength $\lambda = 690\ \mu$m will perturb the crack front over about 4 mm; this misalignment would explain the break in the symmetry and the observed crack surface undulation. The absence of persistence of perturbation noted in the experiment cannot be attributed to the negligible gradients in the energy release rate, since the perturbations of the crack surface are on the same order of magnitude as in the other experiments.

In the third series of experiments reported in [2], conditions used in some of the experiments of Sharon *et al.* [3] were reproduced. In particular, a diamond tool was used to introduce a line scratch on the surface of the specimen, perpendicular to the nominal fracture plane. The fracture surface undulations that result from the encounter of the crack front with the scratch were shown to follow the behavior of Wallner lines established in the first series of experiments reported in [2]. Since the speed of shear waves and the postulated crack front waves differ only by about 10%, and since the uncertainty in the measurement of instantaneous crack speed is about 50 m/s, discrimination between these two waves based on the shape of the tracks on the fracture surface is difficult. However, the amplitude decay characteristics can be explored easily. Sharon *et al.* contend that (i) the amplitude decay measured in our experiments (inset in Fig. 5b in [2]) can be described by an exponential decay [3] and further (ii) that with continued $1/r^2$ amplitude decay, the tracks should become "invisible". Hence they suggest that Fig. 5b in [2] is actually representative of crack front waves. We disagree with both their contentions.

The exponential decay observed by Sharon *et al.* [3] occurs over a length of $(0.9 \pm 0.1)a$ where a is the characteristic width of the surface profile. In the result shown in Fig. 5b of [2], the characteristic width of the surface perturbation is about 100 μm; we found that the amplitude continued to decay over roughly $15a$. The stabilization of the surface perturbation reported in [3] after propagating a distance of $2a$, was not observed. The observation presented in Fig. 5b of [2] cannot be described by an exponential decay similar to Sharon *et al.*[3]. Regarding the issue of "visibility" of the tracks, we note that the tracks are, in fact, not visible; for example, by focusing on the fracture plane in a microscope, these tracks cannot be observed! The tracks were made visible in a shadowgraphic arrangement. We replot Fig. 5b of [2] with logarithmic scales in Fig. 1. The amplitude of the Wallner decays as $1/r$ rather than $1/r^2$; this behavior might be expected since the perturbing scratch is an extended line source rather than a point source. Then, the amplitude should decrease to about 1.3 nm at 15 mm. This can be visualized in our shadowgraphic arrangement with an aperture of 40 μm, and a focal length of about 1 m. Thus, the observed trace on the fracture surface generated from a line scratch has all the characteristics of a Wallner line.

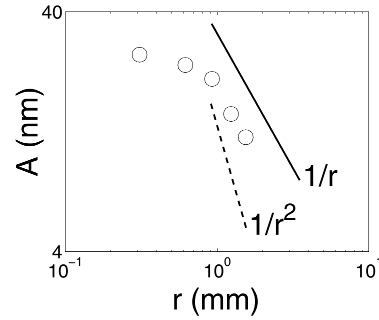

FIG. 1. Variation of the surface undulation A with the distance r from the source. Trend lines of $1/r$ decay (solid line) and $1/r^2$ decay (dashed line) are also shown in the figure.

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