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Supporting information for article:

**Evolution of laser-induced strain in a Ge crystal for the [111]
and [100] directions probed by time-resolved X-ray diffraction
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X-ray diffraction profiles due to strain generated from the longitudinal acoustic wave (Thomsen model) were simulated by integrating the Takagi Taupin (TT) equations (Thomsen *et al.*, 1986). The experimentally observed and simulated X-ray diffraction profiles for Ge (111) Bragg reflection at 11 mJ/cm² excitation fluence are shown in Figs. S1(a) and (b), respectively. In this simulation, first the diffraction profile for pristine crystal is calculated for monochromatic X-rays by the integration of TT equations. Then the point spread function (PSF) of the experimental setup (due to detector resolution, source size and internal X-ray line width) is calculated by convolving the monochromatic X-ray diffraction profile with a pseudo-Voigt profile. The convolved profile is matched with the experimentally observed X-ray diffraction profile from the pristine crystal by adjusting the parameters of the pseudo-Voigt profile. The same pseudo-Voigt profile is then used to convolve monochromatic X-ray diffraction profiles from the pumped crystal to simulate experimentally observed X-ray diffraction profiles.

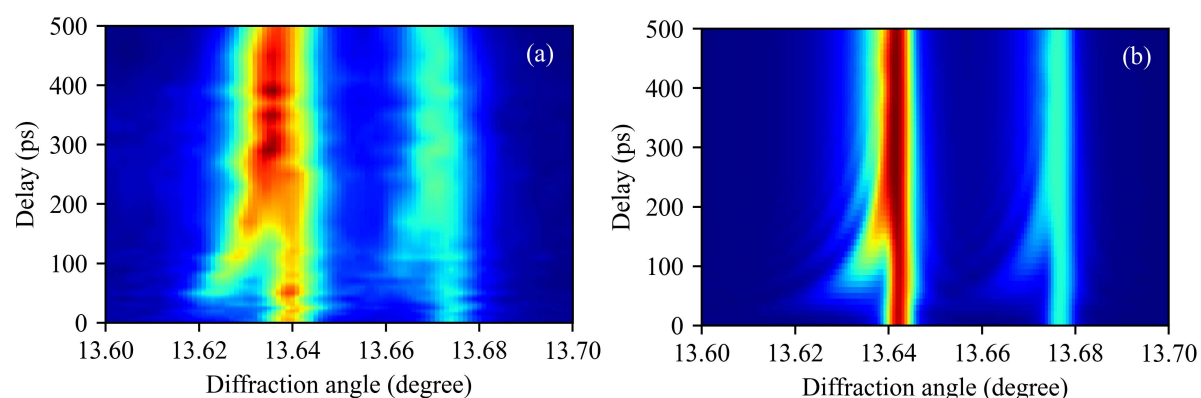


Figure S1. (a) Experimental data: Time- and angle-resolved diffraction curves for optically excited Ge at 11 mJ/cm² fluence. (b) Simulation result showing the diffraction patterns due to propagation of strain generated from the longitudinal acoustic wave (Thomsen model).

At first glance, the experimental and simulated results look similar but it may be noted upon careful inspection that the longitudinal acoustic wave model (Thomsen model) predicts faster recovery than the experimentally observed. The model also predicts a weaker X-ray diffraction signal at larger strain at smaller delays (for ≤ 50 ps), the same can be compared at $\sim 13.62^\circ$. A small compression signal is also observed, which decays with time. The strain and effective laser absorption length of 1.4×10^{-3} and 200 nm, respectively, were taken here for the

closest match of the simulated and experimental pattern. The maximum strain as observed from the difference graph was nearly the same ($\sim 1.2 \times 10^{-3}$).

In the present work, we have proposed a model in which a thin strained crystal is generated due to laser excitation on the top of the pristine crystal. The strained crystal is approximated as a perfect crystal with a different d spacing than the pristine crystal. This approximation is based on the fact that the widths of the X-ray diffraction peaks from the pristine and strained crystals were similar. The increase in diffracted intensity from the strained crystal with delay (Fig. 3 of the main manuscript) may be correlated with the X-ray diffraction intensity as a function of crystal thickness (Fig. 4 of the main manuscript). From this comparison, one can derive the strain propagation velocity (change in thickness of strained crystal with delay) in the crystal. The thickness of the strained crystal increases with time delay and this is attributed to crystal heating by carrier diffusion. This model presents a very simple approach to estimate the strain propagation velocity in the crystal.

References for Supplemental Information:

Thomsen, C., Grahn, H. T., Maris, H. J. & Tauc, J. (1986). *Phys. Rev. B.* **34**, 4129–4138.