Supplemental Material: Band Structure Dynamics in Indium Wires

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Sample Preparation

The samples were prepared following the procedure detailed in [1–3]. A Si(111) substrate with a small miscut was used to ensure the growth of Indium wires in a single (4×1) domain. Phosphorous-doped Si(111) with a resistance $< 0.01\,\Omega$cm and a 1.5° miscut along the $[\overline{11}2]$ direction was annealed to 1100 °C for 10 minutes. Afterwards the temperature was slowly reduced to 850 °C. These steps were repeated until the pressure stayed below 10^{-9} mbar. We then flashed the substrate to 1260 °C and slowly cooled down to 1060 °C followed by a fast temperature decrease to 850 °C to obtain regular steps of monoatomic height on the (7×7) surface [4]. Next we deposited ~ 10 monolayers of Indium on the substrate at room temperature from an electron beam evaporator and annealed the sample at 500 °C for 5 minutes resulting in the desired (4×1) structure. All steps during sample preparation were monitored with low energy electron diffraction (LEED, Fig. 1).

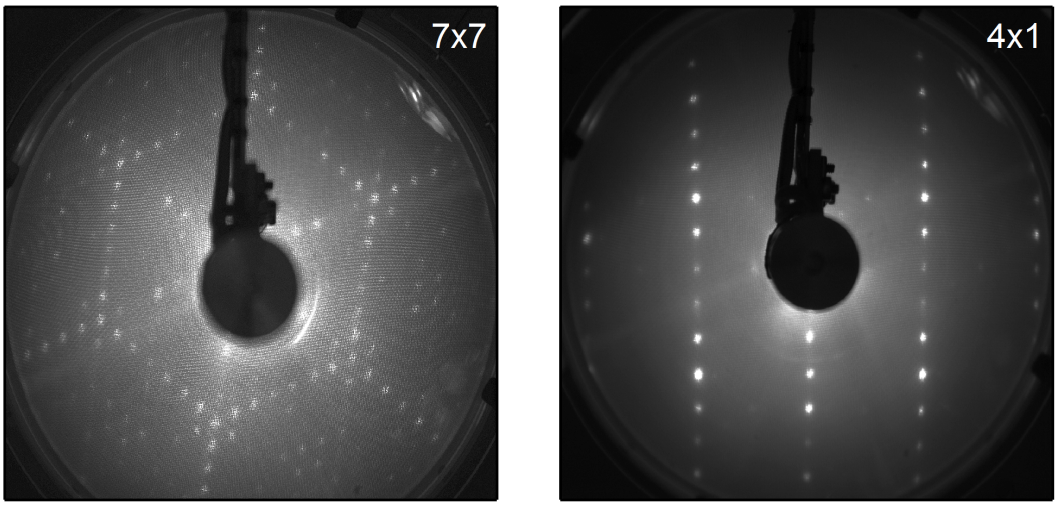

FIG. 1: LEED pictures of the Si(111) (7×7) and the Indium covered (4×1) surfaces taken at 58 eV and 77 eV, respectively.

Tr-ARPES Setup

The tr-ARPES setup was based on a Titanium:Sapphire amplifier operating at a repetition rate of 1 kHz. 2 mJ of output power were used for high harmonics generation in Argon,

producing a broad spectrum of extreme ultra-violet (XUV) light ranging from 10 to 45 eV photon energy. A single harmonic at $\hbar\omega_{\mathrm{probe}} = 26\,\mathrm{eV}$ was selected with a time-preserving grating monochromator [5] and used as a probe pulse for the tr-ARPES experiments. This photon energy was high enough to reach beyond the first Brillouin zone boundary of the In/Si(111) (4×1) phase and measure the complete band structure of the system. After excitation of the sample with a pump pulse ($\hbar\omega_{\mathrm{pump}} = 1.0\,\mathrm{eV}$ or $1.55\,\mathrm{eV}$) the time-delayed XUV pulse ejected photoelectrons that passed through a hemispherical analyzer after which snapshots of the one-dimensional band structure were obtained on a two-dimensional detector. The overall energy and time resolution of the tr-ARPES experiment were 300 meV and 80 fs, respectively.

Data Analysis

We used a step edge plus an exponential decay convolved with a gaussian to fit the pump-probe traces in Fig. 3a and Fig. 4d and the electronic temperature in Fig. 4e of the manuscript. The fitting function is given by

$$I(t) = c + \frac{a}{2}\left[1 + erf\left(\frac{(t-t_0)/\tau - (rt/2.355)^2}{\sqrt{2}(rt/2.355)\tau}\right)\right] exp\left(\frac{(rt/2.355)^2 - 2(t-t_0)\tau}{2\tau^2}\right),$$

where c is a constant offset, a is the amplitude, erf is the error function, t_0 is the middle of the rising edge, and τ is the decay time. The rise time rt is defined as the full width at half maximum of the temporal derivative of the rising edge.

The electronic temperature in Fig. 4e of the manuscript was determined as follows: First, the photocurrent was integrated over the whole momentum axis shown in Fig. 4a and c, yielding a single energy distribution curve (EDC) for each pump-probe time delay. These EDCs were then fitted with a Fermi-Dirac distribution (see Fig. 2).

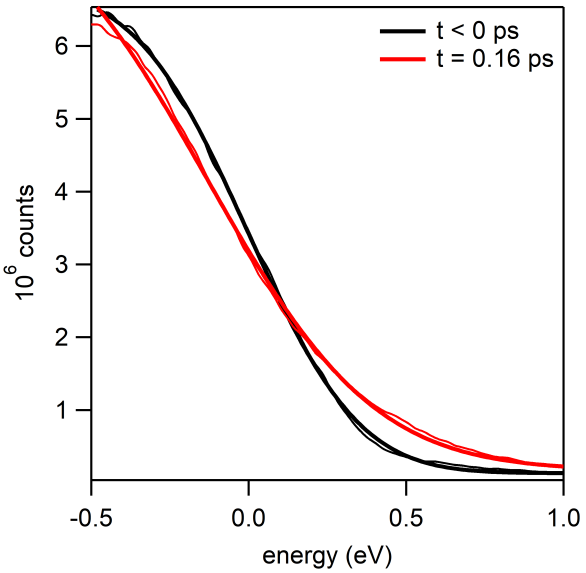

FIG. 2: EDCs (thin lines) at negative delay and at t = 160 fs together with Fermi-Dirac fits (thick lines).

Room temperature tr-ARPES data for 1 eV pump photon energy

To ensure that photoexcitation at 1.55 eV gives similar results as photoexcitation at 1.0 eV we repeated the room temperature measurements with a pump photon energy of 1.0 eV. The results are presented in Fig. 3 for direct comparison with Figs. 3 and 4 in the main text.

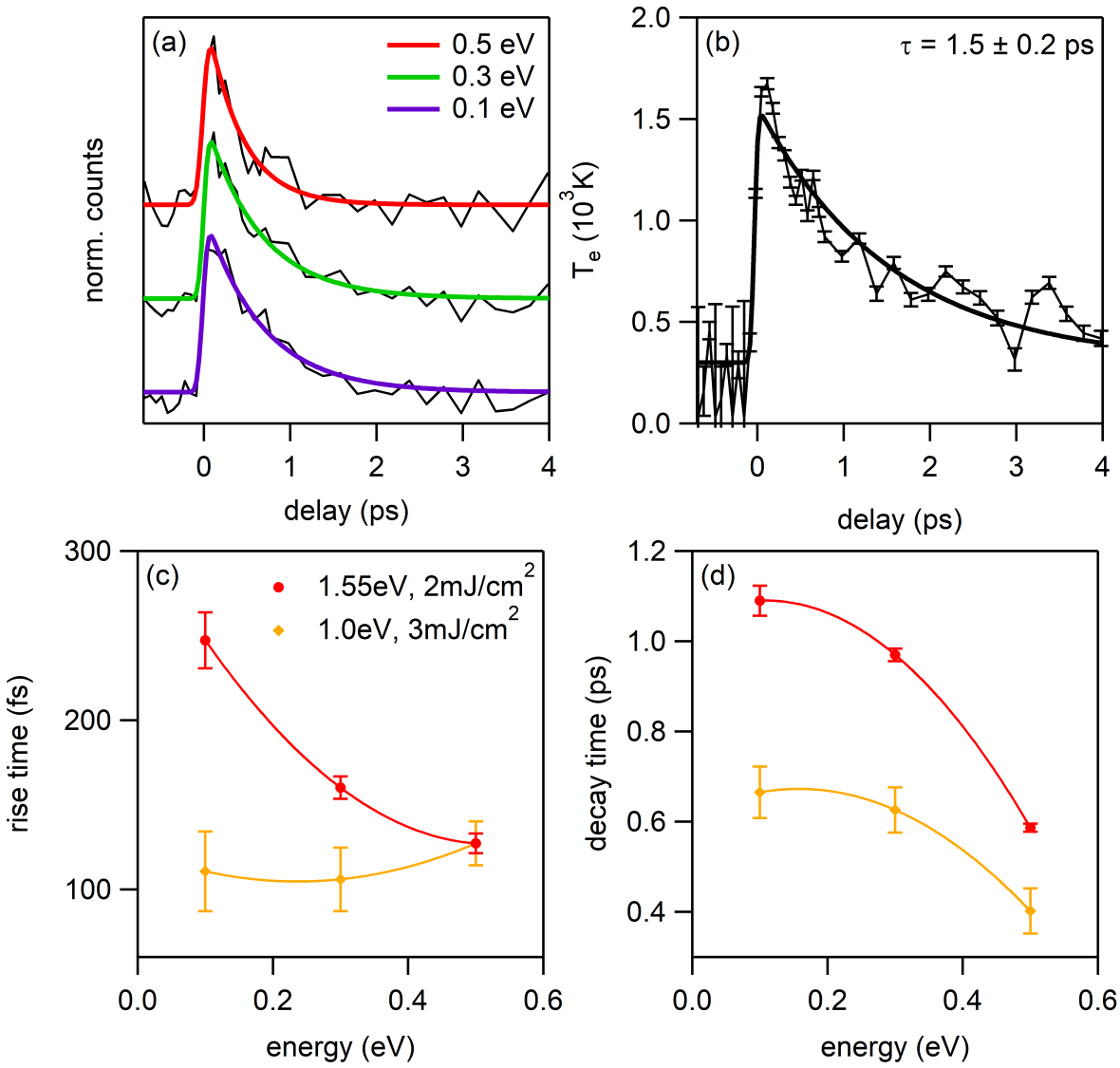

FIG. 3: Dynamics at room temperature for 1 eV pump pulses with a fluence of 3 mJ/cm^2. (a) Pump-probe traces for different energies together with exponential fits. (b) Electronic temperature as a function of pump-probe delay together with exponential fit. (c) Rise and (d) decay time as a function of energy for photoexcitation at 1 eV (orange) and 1.55 eV (red) pump photon energy. Continuous lines in (c) and (d) are guides to the eye.

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