Ultrafast Time Resolved Carrier Dynamics in Tellurium Nanowires using Optical Pump Terahertz Probe Spectroscopy

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SUPPLEMENTARY INFORMATION

S1. Time resolved dynamics of $\Delta\sigma(\tau_{pp})$ using the bi - exponential function

In this section we show the time resolved dynamics of $\Delta\sigma(\tau_{pp})$ along with the fit obtained using the bi - exponential function

$$\Delta\sigma(\tau_{pp}) = \Sigma_{i=f,s} A_i \exp(-\tau_{pp}/\tau_i) \tag{S1}$$

where, A_i is the amplitude and τ_i corresponds to the fast(τ_f) and slow(τ_s) decay time constants.

S1.1 Capping dependent dynamics

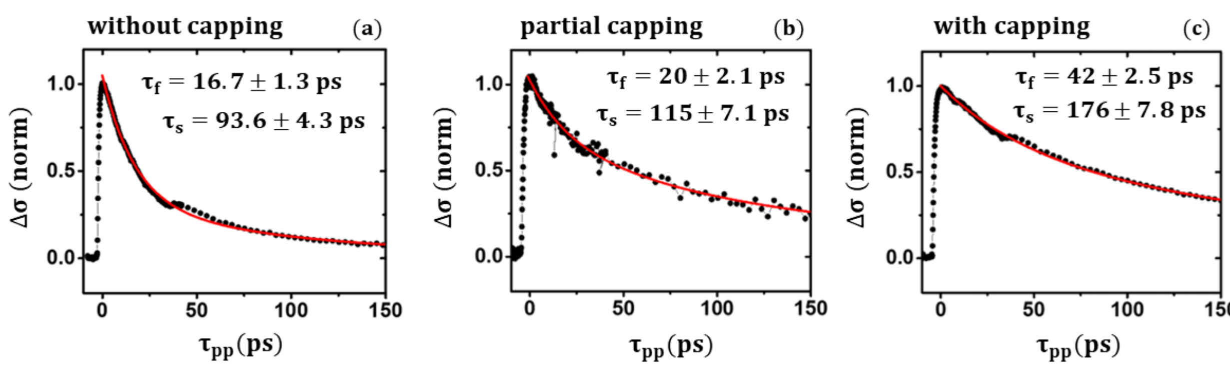

FIG. S1. Normalized dynamics of $\Delta\sigma(\tau_{pp})$ at different capping concentrations (a) without capping, (b) partial capping and (c) with capping at $T_L = 300$ K and $\varphi = 276$ μJ/cm^2. The red solid lines corresponds to the fit obtained using the bi – exponential function along with the timescales presented in the inset

Fig. S2 represents the dynamics of n_s extracted from the rate equation model. The red solid line corresponds to the fit obtained using the function;

$$n_s(\tau_{pp}) = \Sigma_{i=f,s} S_i(1 - \exp(-\tau_{pp}/\tau_{ns(i)})) \tag{S2}$$

The fast time constant (τ_f) governs the dynamics of n_s (Eq. 3), which represents the filling up of the surface state density by the photoexcited carriers. In the supplementary information (SI), we show that the fast time constant associated with the dynamics of n_s ($\tau_{ns(f)}$) closely matches the value of τ_f (shown in Fig. S2). Since, the dynamics of n_s is coupled with the dynamics of charge carriers that relax via. direct electron hole recombination mechanism, direct connection of $\tau_{ns(s)}$ with τ_s is not straightforward. However, the slow time constant (τ_s) estimated from the bi - exponential fitting is attributed to the direct electron – hole recombination process where τ_s closely matches with $\tau_R = 1/(\delta n D_R) \sim 100$ ps as evaluated from the rate equation model

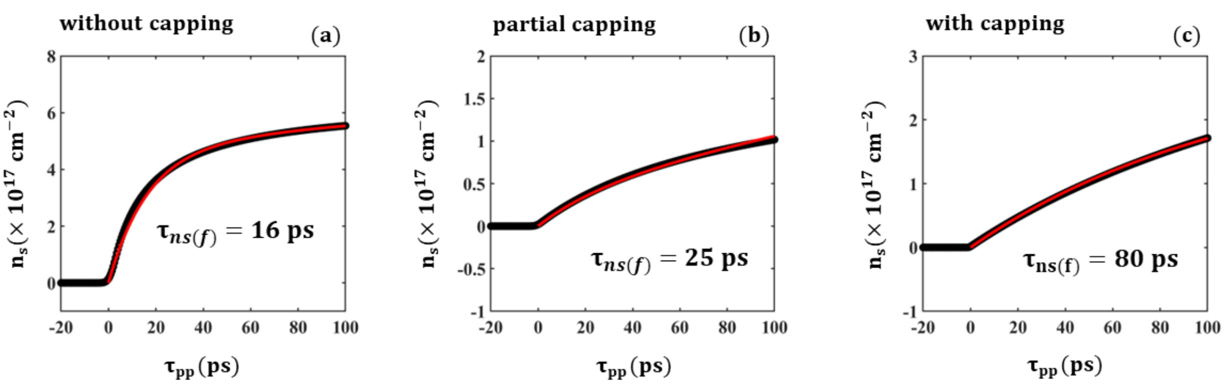

FIG. S2. The time evolution of n_s (black solid circles) extracted using the rate equation model for (a) without capping. (b) partial capping and (c) with capping. The red solid line corresponds to the fit obtained using Eq. S2

S1.2 Temperature dependent dynamics

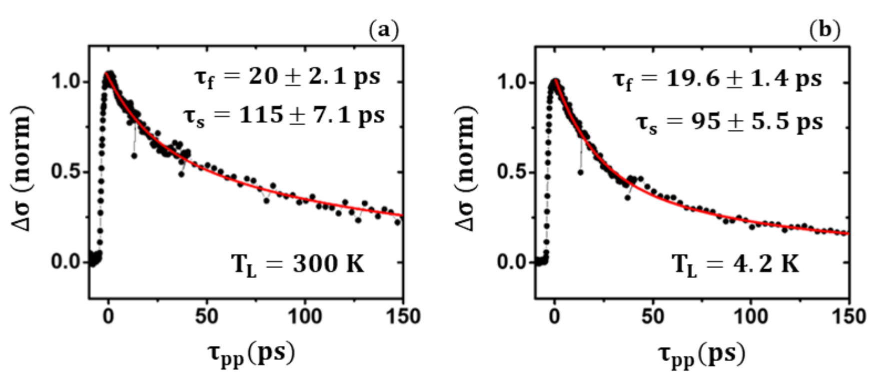

FIG. S3. (a) and (b) shows the T_L dependent dynamics of $\Delta\sigma(\tau_{pp})$ of partially capped TeNWs sample at $T_L = 300$ K and $T_L = 4.2$ K, respectively with $\varphi = 276$ μJ/cm^2. The red solid lines corresponds to the fit obtained using the bi – exponential function along with the timescales presented in the inset

S1.3 Fluence dependent dynamics

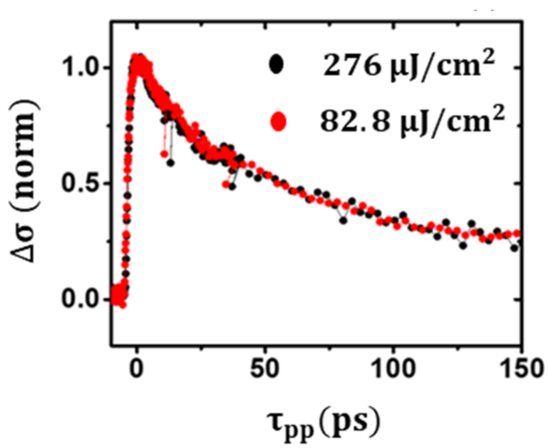

FIG. S4. Represents the dynamics of $\Delta\sigma(\tau_{pp})$ with two pump fluences of $\varphi = 276$ μJ/cm^2 (black) and $\varphi = 82.8$ μJ/cm^2(red) at $T_L = 300$ K.