

Figure S1 Zone sizes measured after laser crystallization on conventional bright-field TEM images as a function of laser pulse energy. The size of each zone is taken as the radius of the minor axis of an ellipse fitted to the outer boundary of each Zone, as illustrated for Zone I in the inset of Figure 2(a) (main text). Each set of three points connected by a drop line are zone sizes for a single spot crystallized at that energy. There are three sets of nearly overlapping measurements at 3.3 μJ . They are differentiated by set of arrows (white, gray, or black), marking each set of measurements for a single crystallization event.

The scatter in the data, gives rise to what may appear like a discontinuity in the sets of data for three 4.0 μJ shots in Figure 3a. In Figure 3(a), a 4.0 shot with measurements from 200 – 900 ns ends at a position of $<15 \mu\text{m}$. Two other $\sim 4.0 \mu\text{J}$ shots with measurements starting at 800 ns have the growth front $>18 \mu\text{m}$ by that time. This apparent discontinuity is simply a result of the variability in crystallized area for the same (or very similar) laser energies.

There are more data points in this plot (and Figure 2(a)) than in Figure 3(a), because this figure includes measurements on conventional TEM images for which no time-resolved image was collected.

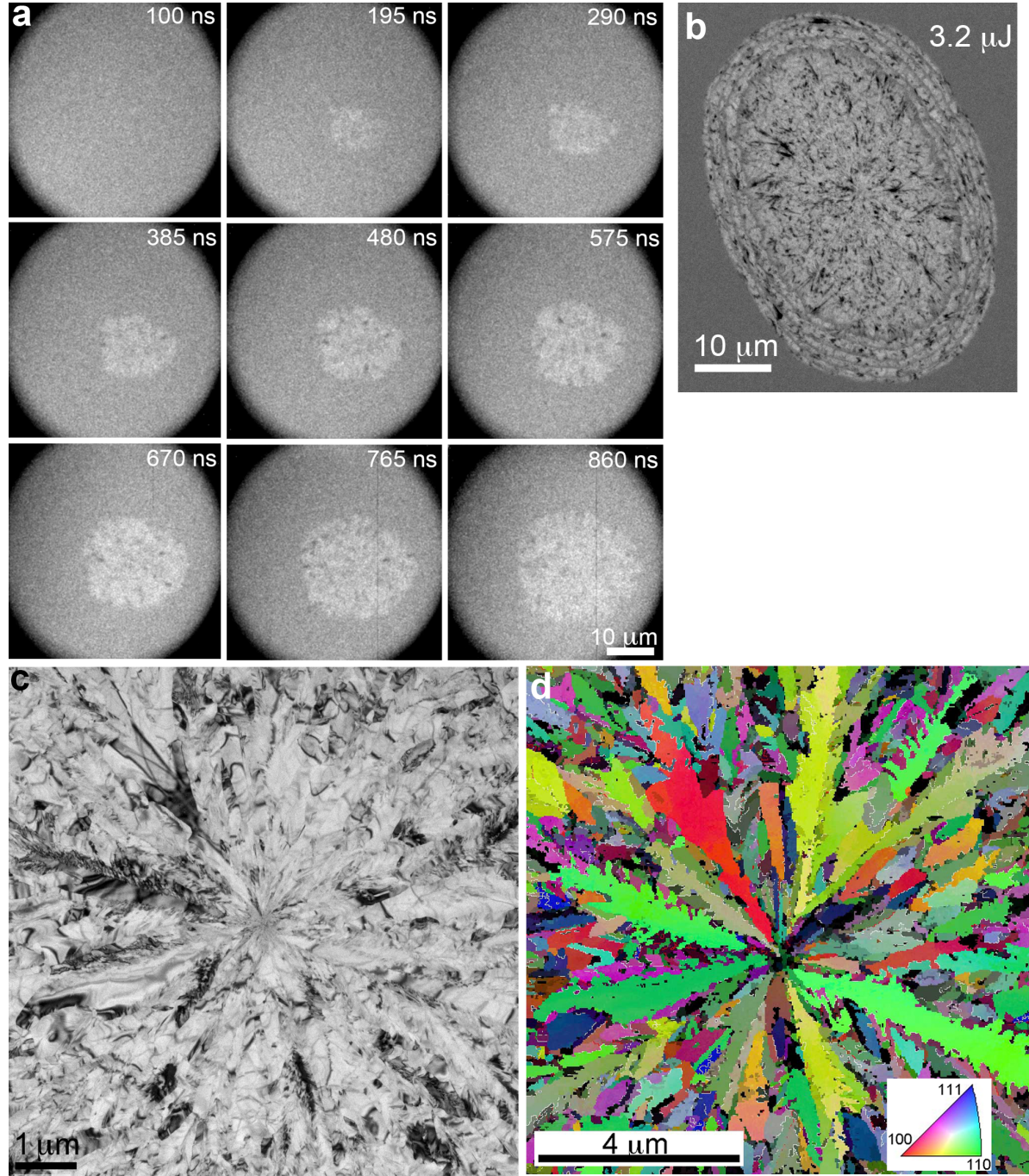


Figure S2 (a) DTEM movie of laser crystallization for the same laser pulse energy as in Figure 2a of the main text, but without the formation of Zone I. Time signatures are relative to the peak specimen laser intensity. (b) Conventional bright-field TEM image of the crystallized area in (a). It lacks the fine-grained structure of Zone I seen at the center of Figure 1a of the main text. (c) Bright-field TEM image (Philips CM300 FEG, 300kV) of the center of (b). The bend contours in the grains of the thin film make it difficult to discern individual grains, but an orientation map (d) generated from TEM nanodiffraction data makes the long narrow grains developed during Zone II growth easier to discern.

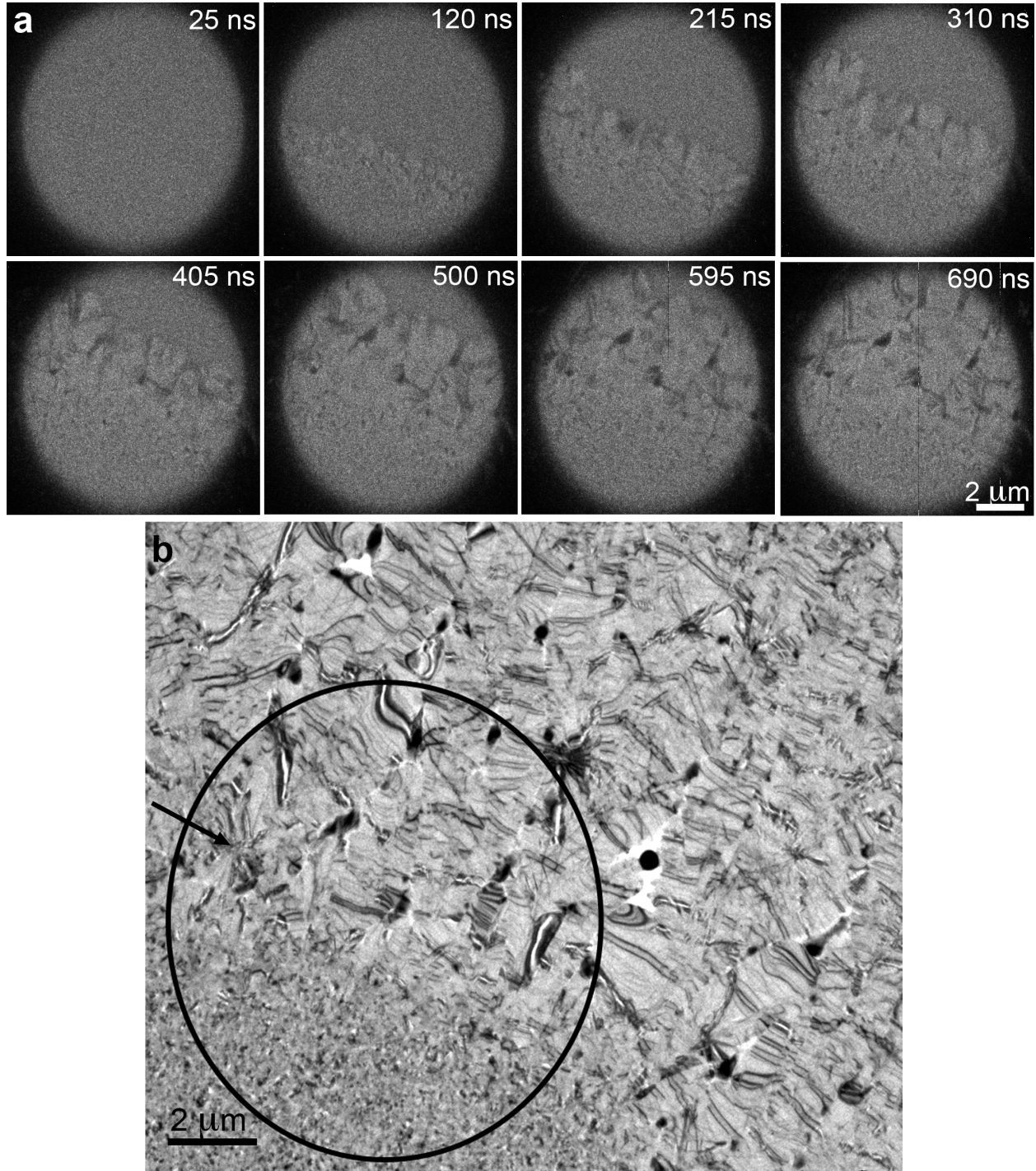


Figure S3 1200X images show unambiguously that the growth front speed is close to 10 m/s immediately after the initiation of Zone II. Zone I is formed and larger Zone II grains have begun to grow by 120 ns after the specimen is heated by the laser. Between 120 ns to 215 ns, the front moves forward by about 1 μm , except at the far left where a nucleation event makes the growth front appear to jump forward almost 2 μm . The crystal front advances by 1 μm in each subsequent frame until 595 ns, after which the front has moved out of the field of view, maintaining a fairly constant rate of just over 10 m/s for 475 ns of Zone II growth. The point where a crystalline area nucleated ahead of the rest of the front is indicated by an arrow in (b).

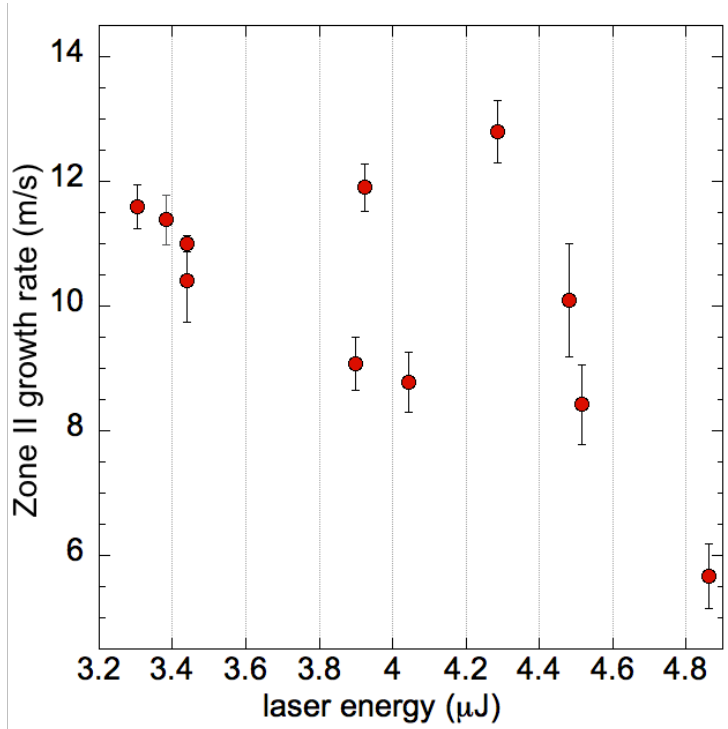


Figure S4 The Zone II growth rate plotted versus laser energy yields no strong trend in the data. The growth rate may be consolidated by plotting it against the Zone I size as shown Figure 2(b) in the main text.