

Supplementary Information for
**In situ observation of coalescence of
nuclei in colloidal crystal-crystal
transitions**

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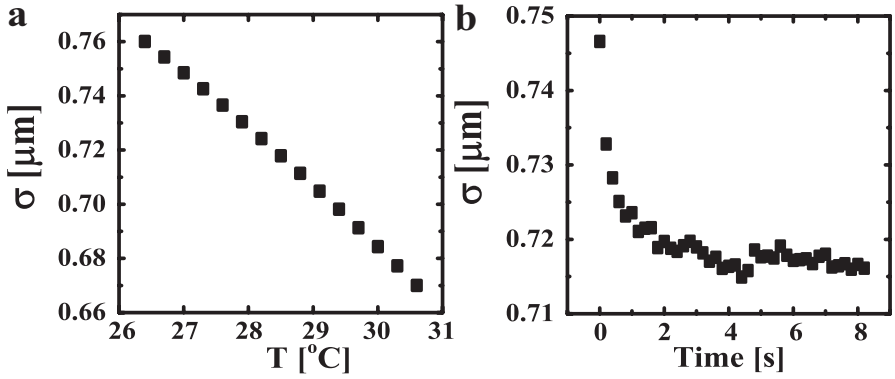
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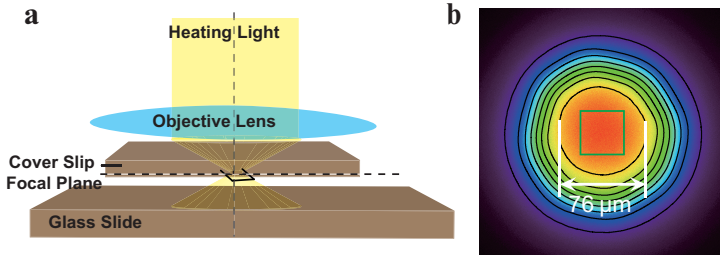
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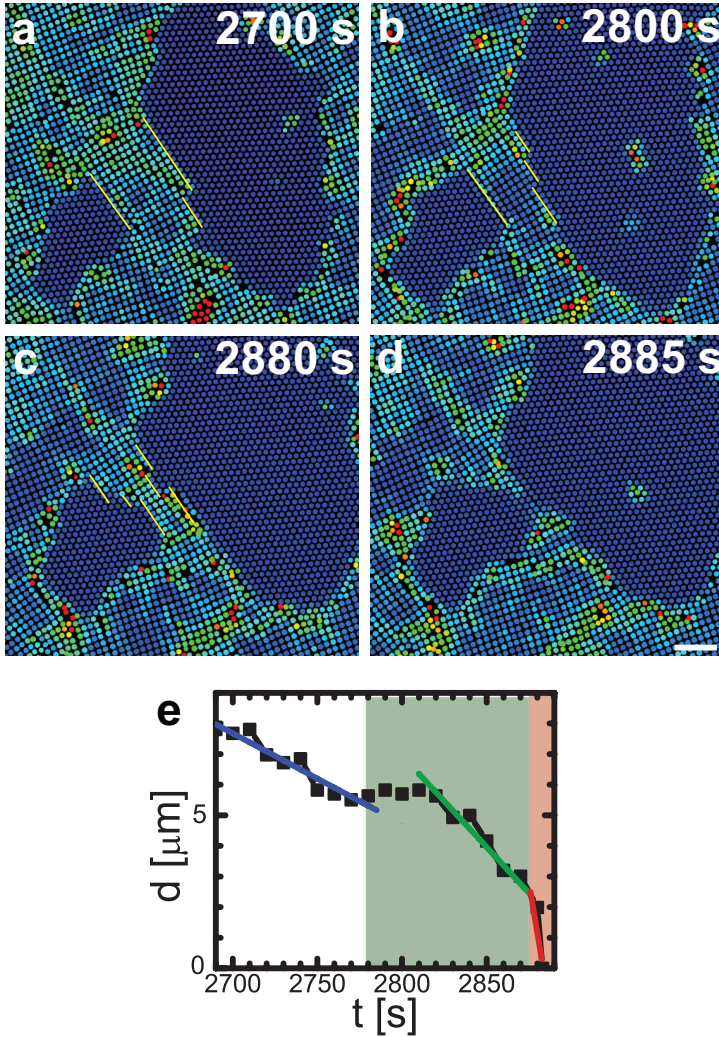
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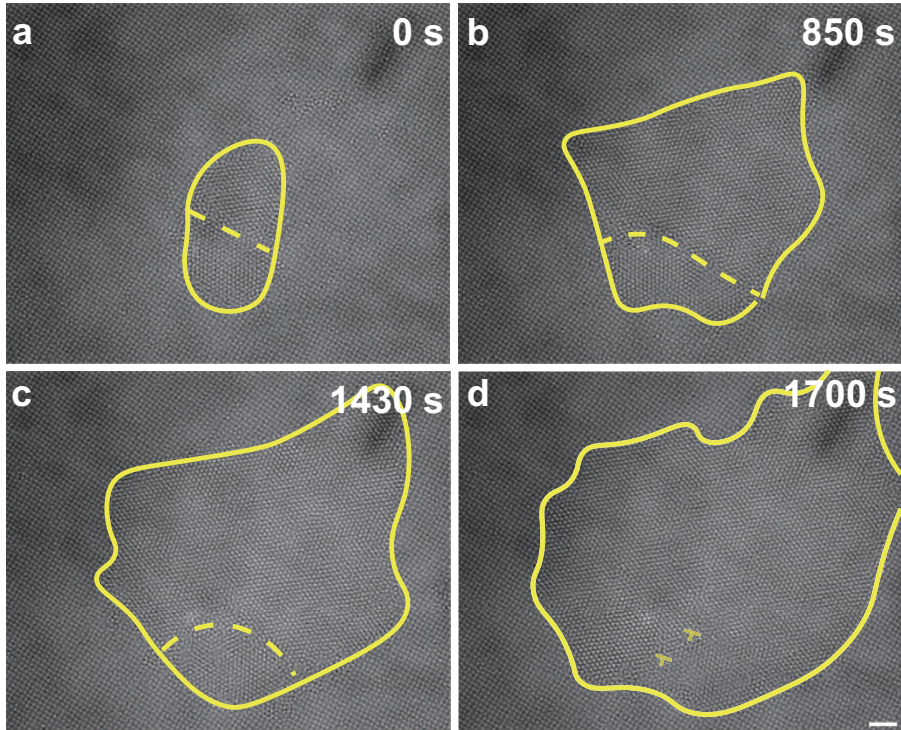
Supplementary Fig. 1 Characterization of colloidal particles. **a**, Mean effective diameter of isolated NIPA microgel spheres stuck onto a glass slide decreases with increased temperature. **b**, Mean diameter of particles stuck onto a glass slide decreases in the first 3 s after switching on the heating light at $t = 0$ s. The figures are reproduced from ref. [1]. Reprinted with permission from AAAS.



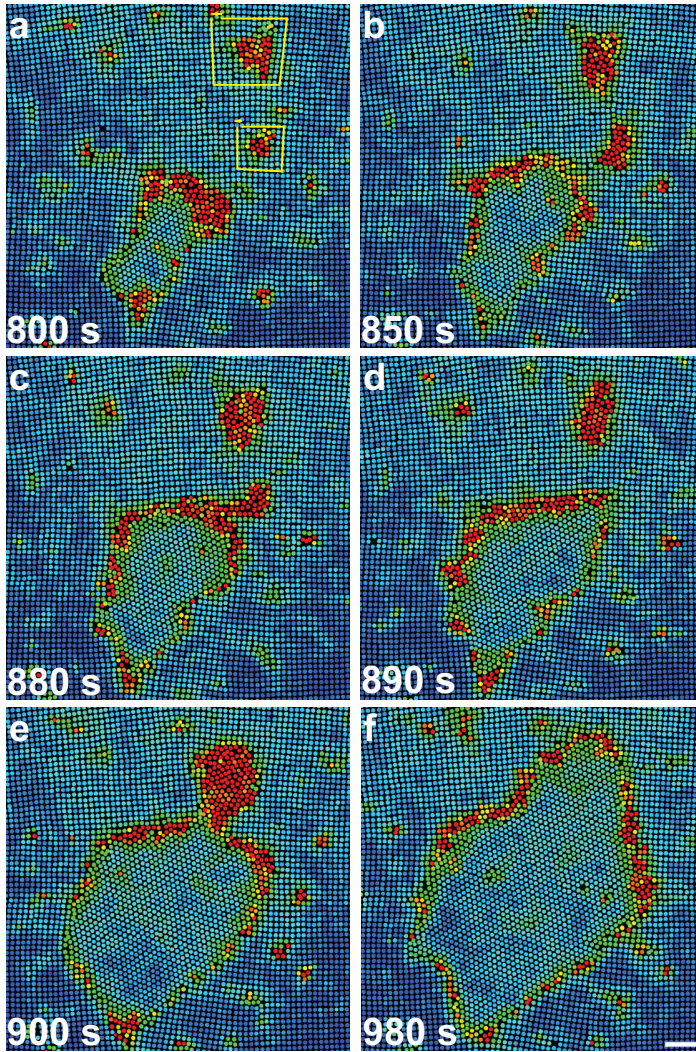
Supplementary Fig. 2 Experimental setup for local heating. **a**, Schematic of local optical heating. **b**, Measured temperature profile in the xy plane. The contour spacing is 0.2°C . The temperature difference in the $\pi(38\mu\text{m})^2$ area of the central circle is less than 0.2°C , which is larger than the field of view (green box).



Supplementary Fig. 3 Typical coalescence of two large Δ -lattice nuclei with coherent $\square$ - Δ interfaces. Particles are coloured by their Lindemann parameters, as shown in Fig. 1. **a**, At $t = 2700$ s, two nuclei whose closest surfaces (yellow lines) and their $[01]$ lattice directions are all parallel to each other. These surfaces are coherent interfaces. **b**, The coherent interfaces approach to each other by ledge mechanisms, compressing $\square$ lattice between them when the separation is around the critical distance ~ 6 particles. The Lindemann parameters of the $\square$ lattice decrease, as shown by the blue particles between yellow line segments, and the approaching speed reduces to zero within 2770–2810 s. **c**, After a temporary stop, new ledges and kinks develop on the coherent interfaces, which rotates the $\square$ lattice and reduces the coherency. The dropped Lindemann parameters increase, and the nuclei grow faster than before. **d**, The expansion of two nuclei distort the $\square$ lattice to Δ lattice, fusing the two nuclei together at $t = 2885$ s. **e**, The separation between two nuclei decreases with time. The green and red regions represent the stages that nuclei grow faster and merge together, respectively. Scale bar: $5 \mu\text{m}$.



Supplementary Fig. 4 The migration of a GB after two nuclei coalesced. **a**, Two nuclei coalesce and form a grain boundary between them. Solid curves indicate the interface between two phases, and dashed curves the GBs. **b**, The upper grain of product phase grow faster and the lower one slower. **c**, The GB between two grains move the the smaller grain. **d**, The smaller nucleus rotates, the GB disappears and two dislocations ($\perp$) are left. Scale bar: 5 μm .



Supplementary Fig. 5 Two small liquid nuclei absorbed by a large Δ -lattice nucleus. Particles are coloured by their Lindemann parameter shown in Fig. 1. **a**, Two metastable liquid nuclei form at the dislocations, signified by open Burgers circuits (yellow loops) and Burgers vectors (yellow arrows). **b**, They are elongated when the growth of the large Δ -lattice nucleus changes the nearby strain field. **c**, The first liquid nucleus is absorbed into the Δ -lattice nucleus and **(d)** recrystallises, and then **(e)** the second liquid nucleus is absorbed and **(f)** recrystallises. Scale bar: 5 μm .

References

- [1] Wang, Z., Wang, F., Peng, Y., Zheng, Z. & Han, Y. Imaging the homogeneous nucleation during the melting of superheated colloidal crystals. *Science* **338**, 87–90 (2012).