Supplementary Information:

Controllable 2H-to-1T' phase transition in few-layer MoTe₂

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Figure S1. Characterizations of a few-layer MoTe₂ before laser irradiation and after laser irradiation

Figure S2. The stability of laser-induced 1T'-MoTe₂

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Figure S4. Raman spectra of few-layer 2H-MoTe₂ and 1T'-MoTe₂

Figure S5. The correlation of laser power and phase transition in a few-layer MoTe₂

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Figure S8. Probing of the absence of oxide on the surface of a few-layer MoTe₂ after laser irradiation



Figure S1. Characterizations of a few-layer MoTe₂ before laser irradiation and after laser irradiation. a-c, Optical microscopic image, AFM image and Raman mapping of 2H-MoTe₂. The scale bar is 2 μ m. The Raman mapping is defined by 2H-MoTe₂ Raman peak at 235 cm⁻¹ with peak width of 20 cm⁻¹; d-f, Optical microscopic image, AFM image and Raman mapping of laser-patterned 2H-MoTe₂ with 1T'-MoTe₂ on the top (laser power: 10 mW) and bottom areas (laser power: 10 mW). The laser irradiation time was 10 mins with 0.2 s per point. The Raman mapping is defined by 1T'-MoTe₂ Raman peak at 125 cm⁻¹ with peak width of 20 cm⁻¹.



Figure S2. The stability of laser-induced 1T'-MoTe₂. a, Optical microscopic image of a laser-patterned few-layer MoTe₂. The scale bar is 3 μm; **b**, Optical microscopic image of a laser-patterned few-layer MoTe₂ after 8 days in ambient conditions; **c,d**, Raman mapping of MoTe₂ after 8 days defined by 125 cm⁻¹ (1T' phase) and 235 cm⁻¹ (2H phase) with spectra width of 20 cm⁻¹; **e,f**, Raman spectra of 1T'-MoTe₂ and 2H-MoTe₂ before and after 8 days in ambient conditions, demonstrating no obvious decay in both 1T' and 2H phase MoTe₂.



Figure S3. Laser thinning effect in MoTe₂ under different irradiation conditions. a,b, Raman spectra of a few-layer MoTe₂ after laser irradiation with various laser power and irradiation time, respectively. The Raman signals of silicon (~520 cm⁻¹) gradually increase as the applied laser power and irradiation time, indicating enhanced laser thinning effect in a few-layer MoTe₂.



Figure S4. Raman spectra of few-layer 2H-MoTe₂ and 1T'-MoTe₂



Figure S5. The correlation of laser power and phase transition in a few-layer MoTe₂. a, Optical microscopic image of a laser-patterned few-layer MoTe₂. The inset is the flake thickness (~ 8nm) determined by AFM. The applied laser power of each square is marked by the white numbers with unit of mW. **b**,**c**, Raman mapping of patterned MoTe₂ defined by two characteristic peaks at 235 cm⁻¹ (2H-MoTe₂) and 125 cm⁻¹ (1T'-MoTe₂), respectively. **d**,**e**, Raman spectra of MoTe₂ and Si after laser patterning, respectively.



Figure S6. EDX analysis of MoTe₂. a, Laser-patterned few-layer MoTe₂ sample with thickness of ~8 nm. The scale bar is 10 μ m; The red and blue squares mark the positions for EDX spectrums; **b,c,** Raman mapping of 1T' phase and 2H phase of MoTe₂ defined by 125 cm⁻¹ and 235 cm⁻¹, respectively; **d,e,** Typical EDX spectrums of 1T' phase and 2H phase of MoTe₂ taken from Figure S6a; **f,g,** The measured percentage of concentration of Mo and Te elements in 1T' phase and 2H phase of MoTe₂, respectively.



Figure S7. Te treatment of laser-induced 1T'-MoTe₂. a-c, optical microcopy and Raman mapping of a few-layer $1T'-MoTe_2$ induced by laser irradiation. The Raman mapping are defined by two peaks at 125 cm⁻¹ (1T' phase) and 235 cm⁻¹ (2H phase), respectively. The scale bar is 3 µm; d-f, characterizations of $1T'-MoTe_2$ after Te treatment at 650 °C, showing no signature of reverse 1T'-to-2H phase transition.



Figure S8. Probing of the absence of oxide on the surface of a few-layer MoTe₂ after laser irradiation. a-c, Optical microscopic image and Raman mapping of laser irradiated MoTe₂. The scale bar is 2 μ m. Raman mapping are defined by two peaks at 125 cm⁻¹ (1T' phase) and 235 cm⁻¹(2H phase), respectively; **d**, Raman spectra taken from A and C area before laser irradiation and after. The vertical dashed line indicates the possible peak position of MoO₃ at 820 cm⁻¹; **e**, Raman mapping of MoTe₂ after phase patterning defined by the peak at 820 cm⁻¹ (MoO₃), showing no signature of oxide.