

Description of Additional supplementary files

Supplementary Movie 1:

Video showing the experimentally measured HCP intensity distribution from 20 to 20.45 mm in air, acquired using the monitoring system shown in Fig. 3a. Two neutral density (ND) filters were placed before the mask to reduce the illumination power.

Supplementary Movie 2:

Video recorded using an optical microscope (Keyence VHX-X1), capturing capillary flow within the high-aspect-ratio hollow HCP lattice structure from a 45° viewing angle.

Supplementary Movie 3:

Video of in situ uniaxial micro-compression performed using a flat-punch nanoindenter (μ TR, MTR-3-XR) inside a scanning electron microscope (FEI Teneo SEM), showing displacement from 0 to 502.5 μm . Each SEM frame has a resolution of 4096×4096 pixels, with an acquisition time of approximately 70 s per image.