

Description of Supplementary Files

Manuscript 2: Supplementary Movie 1

Operando synchrotron X-ray video of “on-off” build track overlaid with surface morphology measured with ICI. X-ray imaging rate is 1 kHz. ICI imaging rate is 100 kHz, downsampled by a factor of 100 using a weighted average with weights of ICI signal intensity. Time is relative to the initial laser on time. The first laser on period is not included as most of the ICI data was from the substrate, due to the imaging/laser beam offset of 1-1.75 mm. Total track length is 14 mm, laser switched on for 0.8 s (2 mm) then off for 0.4s (1 mm), four times. Process parameters: laser power 200 W, traverse speed 2.5 mm/s, 2.15 g/min, substrate material IN718, powder material CM247LC.

Manuscript 2: Supplementary Movie 2

Operando synchrotron X-ray video of crack growth following laser deposition of the 5th layer on one of the valleys in a CM247 pre-build with seeded humping. X-ray imaging rate is 1 kHz. Time is relative to t_0 , when the tail of the melt pool reaches the center of the valley. Radiograph contrast has been enhanced using Matlab’s built-in function “imadjust”. Process parameters: laser power 200 W, traverse speed 5 mm/s, 2.15 g/min, substrate material CM247LC pre-build, powder material CM247LC.

Manuscript 3: Supplementary Movie 1

Operando synchrotron X-ray video of a ~9.5 mm line weld on aluminium 6061. X-ray imaging rate is 140 kHz, scale bar is 100 μm , and the laser was turned on at 0 s. Process parameters: laser power 253 W, laser spot size ($1/e^2$) 47 μm , scan speed 510 mm/s.