Imaging of dynamic processes in materials using high-repetition rate betatron x-rays

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Betatron X-rays from a laser wakefield accelerator (LWFA) provide a new avenue for high-resolution, high-throughput radiography of complex dynamic processes in materials. We present the application of betatron X-rays for three-dimensional tomography of porosity evolution in additively manufactured aluminium alloys under tensile stress. Using the high-stability LWFA X-ray beamline at the Advanced Laser Light Source (ALLS) in Varennes, Canada, we investigated the effect of pressure/stress ratios on porosity evolution in AlSi10Mg alloys under increasing tensile load, leading to material fracture. High-resolution X-ray tomography of porosity evolution under material deformation provide critical porosity evolution curves needed to validate detailed models of material degradation, and explain the underlying mechanisms driving ductile fracture in additively manufactured alloys. The ALLS betatron beamline was optimized and characterized for high-throughput, high-resolution betatron imaging at 2.5 Hz.

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