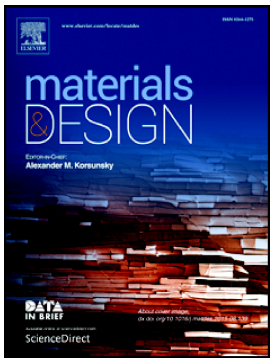

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The Full-field Strain Distribution and the Evolution Behavior during Additive Manufacturing Through In-situ Observation

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Abstract: Part distortion is a technical bottleneck in the field of metal additive manufacturing, which generally depends on the thermo-mechanical behavior the material experienced during the deposition process. However, the transient strain distribution and evolution behavior of the additive manufactured part still remain unclear due to the lack of in-process observation method. This study successfully obtained the continuous full-field strain of a Ti-6Al-4V thin-wall during the laser engineered net shaping (LENS) additive manufacturing process using Digital image correlation (DIC) method. The evolution characteristic of vertical strain and longitudinal strain of the material was primarily studied during the deposition process. The results shows that the longitudinal strain was found increases rapidly to tensile strain as the laser beam approaches, whereas the vertical strain decreases rapidly to a compressive strain and gradually transform to tensile strain. Both vertical strain and longitudinal strain were found accumulated and rose periodically when depositing multi-layers, which increases the distortion tendency of the deposited part. In situ measurement of the strain field in additive manufacturing process can be an effective verification for theoretic and computational studies, which also provides the possibility of controlling stress and distortion in real time.

Keywords: Additive manufacturing; Strain; Distortion; In-situ observation; Digital image correlation; Titanium alloys.