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# The graded microstructures evolving with thermal cycles in pure copper processed by laser metal deposition

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**Abstract** A single-trace copper wall is deposited by laser metal deposition and oxygen is introduced via removing the vacuum protection equipment. The corresponding microstructures at different positions are characterized by optical microscopy, scanning electron microscopy and transmission electron microscopy. Graded microstructures with the equiaxed grains of copper, macro-precipitates of Cu<sub>2</sub>O in top position and equiaxed grains, macro-precipitates and nano-precipitates of Cu<sub>2</sub>O in bottom position are obviously observed. The macro-precipitates are formed in the primary thermal cycle while the nano-precipitates are formed in the latter thermal cycles and contribute to larger hardness. This work reveals the microstructure evolution of Cu<sub>2</sub>O precipitate and indicate the specific mechanical priority of copper production by additive manufacturing.

**Key words:** Laser processing, Thermal cycles, Nano-size, Particles.

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## 1. Introduction

A new processing of additive manufacturing (AM), including the laser metal deposition (LMD), selective laser melting (SLM) and selective electron beam melting (SEBM), is characterized for its material saving, precise formation and decreased defect properties. The specimen or component processed by AM is built track by track to form a layer, then layer by layer to form a complicated structure. The

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