

Crystal Growth Mode Changes during Pulsed Laser Induced Rapid Solidification in Nanoscale Thin Films of Al-Cu Eutectic

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Pulsed laser induced rapid solidification is a promising processing method to produce unique microstructures and micro-constituents in metallic thin films at the nano-scale [1]. Recent in-situ dynamical transmission electron microscopy (DTEM) studies on the rapid solidification of hypo-eutectic Al-Cu alloys have identified various growth mode changes with modulation of the microstructural features [2]. Elucidating crystallographic orientation changes during growth mode transition are of fundamental importance in understanding rapid solidification processes [3-5]. Due to the nano-crystalline nature of the resulting microstructure, acquiring statistically significant and representative data sets is rather difficult with electron backscatter pattern based orientation image mapping (OIM) by scanning electron microscopy. With the recent development of transmission electron microscopy (TEM) based OIM, which relies on automated acquisition and indexing of precession electron diffraction (PED) patterns, changes in crystal orientation and crystal structure can be detected with nanometer spatial resolution [6-8].

Here we present and discuss results analytical TEM/STEM studies of Al-16at.% Cu eutectic alloy thin films after pulsed laser induced rapidly solidification. Figure 1 illustrates morphological changes associated growth mode transitions, including from a regular lamellar eutectic growth mode to irregular eutectic cell growth followed by finally growth at rates above the velocity of absolute stability, implying an increasing solidification rate. Figure 2 documents a crystallographic orientation change during rapid solidification identified by PED OIM, e.g. marked in the (001) inverse pole figures. The details of growth mode changes and associated phase, compositional and crystallographic orientation changes will be analyzed and discussed.

References

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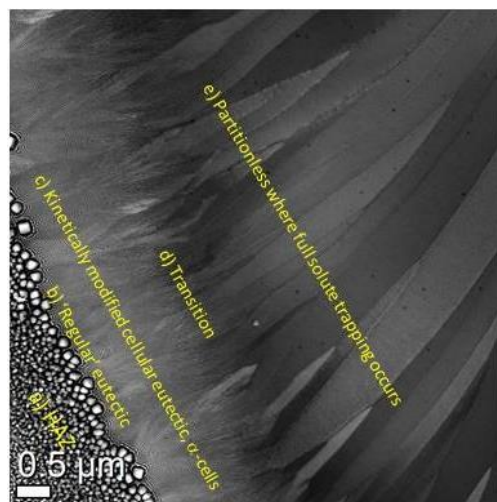


Figure 1. Annular dark field scanning transmission microscope image of the morphologically different zones in rapidly solidified Al-16at.%Cu eutectic thin films.

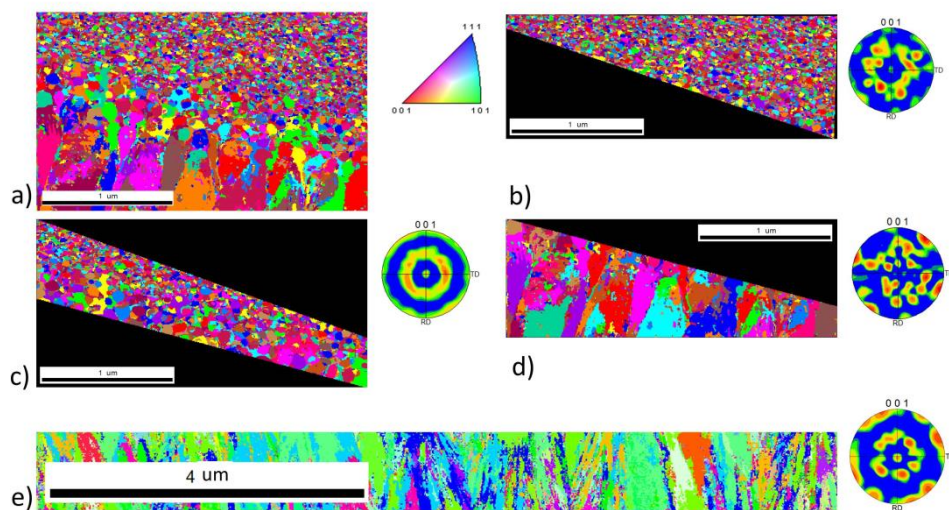


Figure 2. PED TEM OIM maps of a) area corresponding to the edge region of the melt pool, where a texture change in transition between b) and c) is observed. In d) the starting of columnar solidification is shown, and e) displays the end of the kinetically modified eutectic growth zone.