Quantitative cellular automaton model for the simulation of anomalous eutectic growth during SLM process

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Anomalous eutectic is formed during solidification of binary eutectic alloy. Anomalous eutectic was firstly observed during the undercooled solidification of Ag-Cu[6] and Ni-Sn[3]. Three insights of anomalous eutectic growth mechanism have been summarized[4]: one phase is continuous and the other is discontinuous[1], both phases are continuous[3], both phases are discontinuous[2, 7]. Anomalous eutectic morphologies were also found at the bottom of melt pool during SLM of Ni-Sn eutectic powders once and twice[5]. Up to date, the morphological evolution of anomalous growth is still unknown, such as that how is the β-Ni_3Sn matrix formed and what is the transition mechanism from anomalous eutectic to lamellar eutectic. We focused on the microstructure evolution of anomalous growth during laser remelting of Ni-Sn alloy powders. Fig.1 shows the backscattered electron images of anomalous eutectic at the bottom of melt pool after laser remelting Ni-30wt.%Sn powders twice. The details of experiments can be seen in author Lin's recent paper[5].

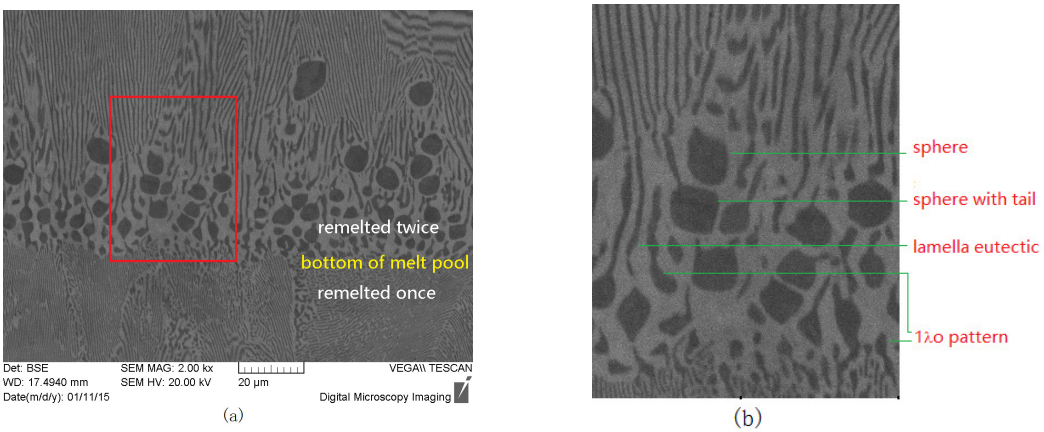

Figure 1: Backscattered electron images of anomalous eutectic at the bottom of melt pool after laser remelting Ni-30wt.%Sn powders twice

Quantitative cellular automaton (CA) model for anomalous eutectic growth is introduced. It is indicated that anomalous eutectic growth is not simply caused by rapid solidification. A "remelting→slowly

solidifying→rapidly solidifying" process is essential. Anomalous eutectic is formed in the "slowly solidifying" region. CA simulation of microstructure evolution shows that larger sphere α-Ni nucleations are rapidly wrapped by β-Ni_3Sn; smaller α-Ni nucleations grow into lamellar eutectic coupled with β-Ni_3Sn. Thus the competitive growth between anomalous and regular eutectic has been observed. We also discover that the cooling rate determines whether it is epitaxial growth of regular eutectic or anomalous eutectic growth with α-Ni nucleations.

References

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