Analysis of texture evolution of additive manufacturing FeMnCrNiMo high entropy alloys under different laser energy density

方　偉[1)]　徐　平光[2)]
Wei FANG　Pingguang XU
[1)]河北工業大学　[2)]原子力機構

Abstract: The investigation of texture in alloys prepared by laser powder bed fusion is of significant importance for optimizing process parameters and predicting material properties. However, a systematic study on the correlation between bulk texture characteristics and microstructural features in the melt pool is still lacking. In this study, we use distinct scanning strategies to obtain several typical melt pools of nickel-based alloys. A clear connection between texture characteristics and microstructural features in the melt pool was established through neutron diffraction, electron backscatter diffraction, and backscattered electron techniques. Our work provides valuable insights for an underlying understanding and regulation of microstructural and texture characteristics in additively manufactured alloys.
Keywords : neutron diffraction, texture analysis, additive manufacturing, scanning strategies, microstructure

１．Research Purposes

Although texture in additively manufactured nickel-based alloys have been extensively studied, there remains a lack of systematic research on the correlation between texture and the microstructure of the melt pool. For example, the corresponding relationship between the texture component and the microstructure of different areas in the melt pool is not yet clear. In addition, When the statistically sampled area is small and the number of grains is low, there are significant fluctuations in texture components, strength, etc. In this work, we will employ various characterization techniques including neutron diffraction, electron backscatter diffraction, optical microscope, and scanning electron microscope to study related topics.

２．Experimental Procedures

Textures of nickel-based alloys prepared by laser powder bed fusion, with distinct scanning strategies, were measured using RESA neutron diffraction at JRR-3. In addition, conventional microstructure analysis techniques such as transmission electron microscopy and electron backscatter diffraction were employed complementarily. The neutron diffraction results were analyzed using the MAUD texture software.

３．Results and discussion

A typical fine-grained region in the center of the melt pool corresponds to the Cube texture, while the peripheral region presents a columnar grain structure that is important for the development of the Goss texture. For the sample with interlayer rotation of 45°, {100} texture corresponding to the fine-grained region appears with an approximately 22.5° declination, and the growth of columnar grains deviates from the maximum temperature gradient, indicating that microstructural features are influenced by the dual effects of the maximum temperature gradient and grain orientations of remelted regions. This approach will contribute to expanding our understanding of the texture in the field of additive manufacturing through the utilization of neutron diffraction at JRR-3.

４．References

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