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Influence of substrate surface morphology on wetting behavior of tracks during selective laser melting of aluminum-based alloys

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Key words:
Selective laser melting (SLM); AlSi12; Surface morphology; Single track

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Typical morphologies of single tracks on the samples

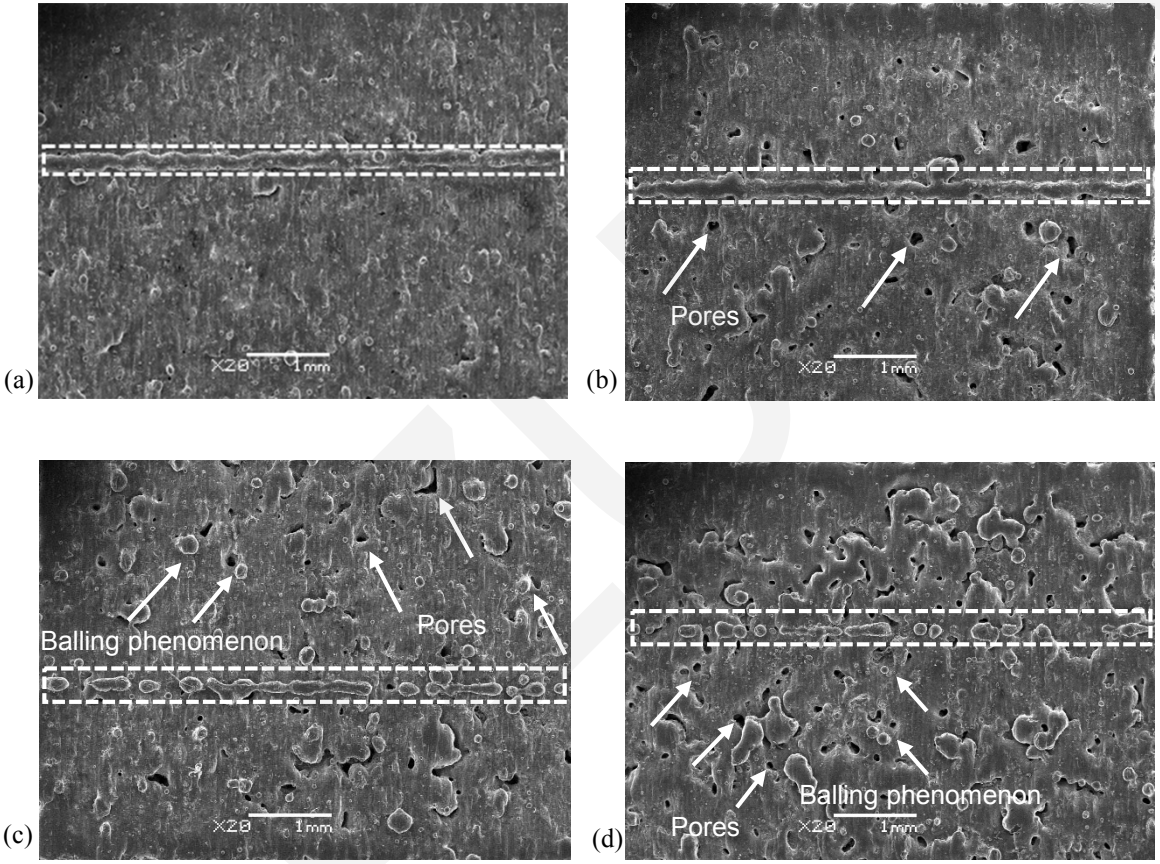


Fig. 1 Surface morphology of the SLM samples using different processing parameters: (a) dense sample; (b) sample with less pores; (c) sample with more pores and balls; (d) sample with a large number of pores and balls

Typical morphologies of single tracks on the samples

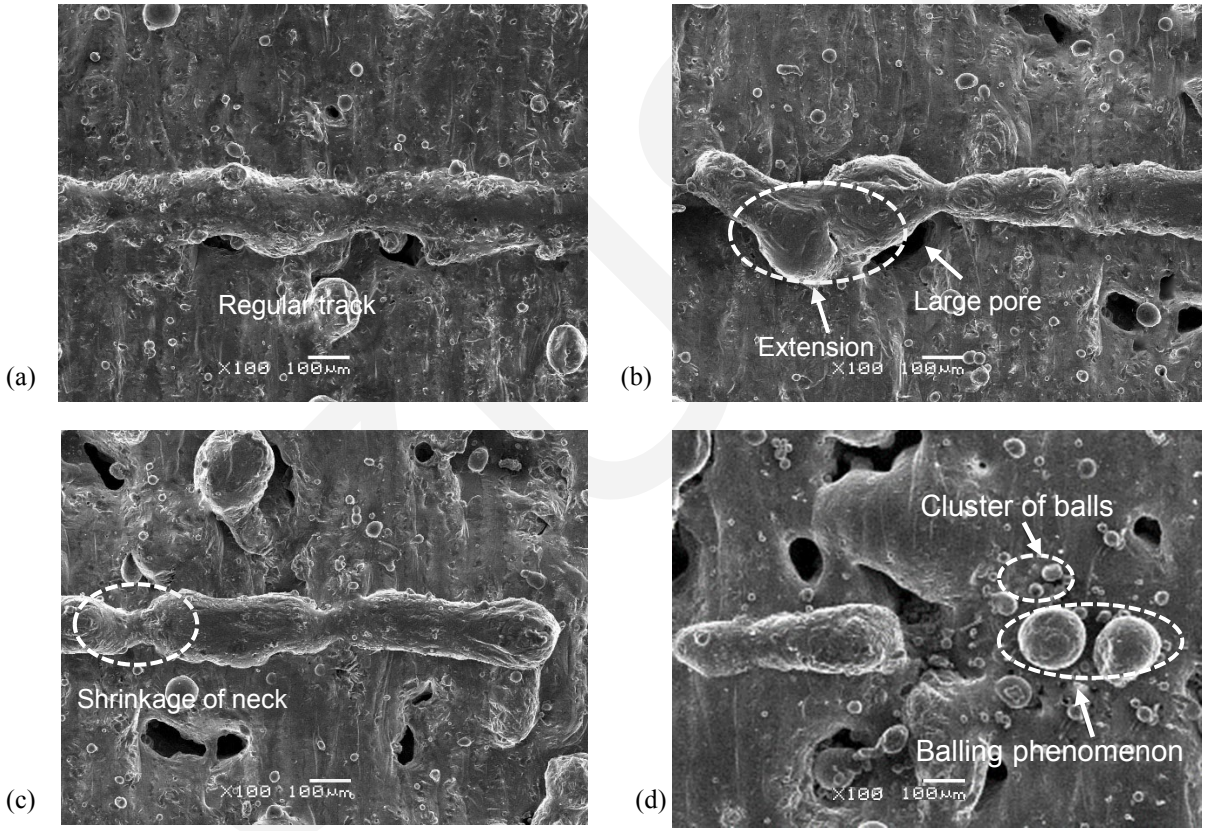


Fig. 2 Four typical types of single track prepared on various surface morphologies: (a) regular track; (b) extension of the single track; (c) shrinkage of neck of the single track; (d) balling phenomenon

Dimensions of cross-section of single tracks

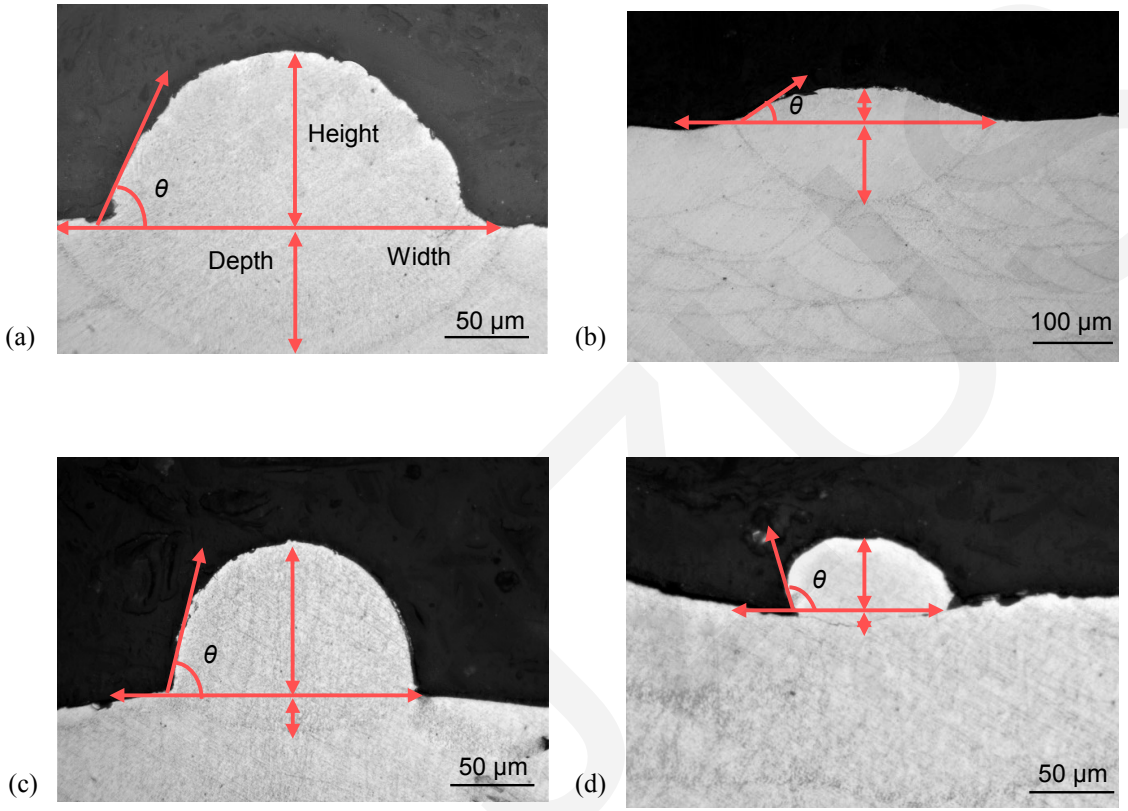


Fig. 3 Cross-sectioned images of the four typical single tracks: (a) regular type; (b) extending type; (c) shrinkage of neck type; (d) balling type

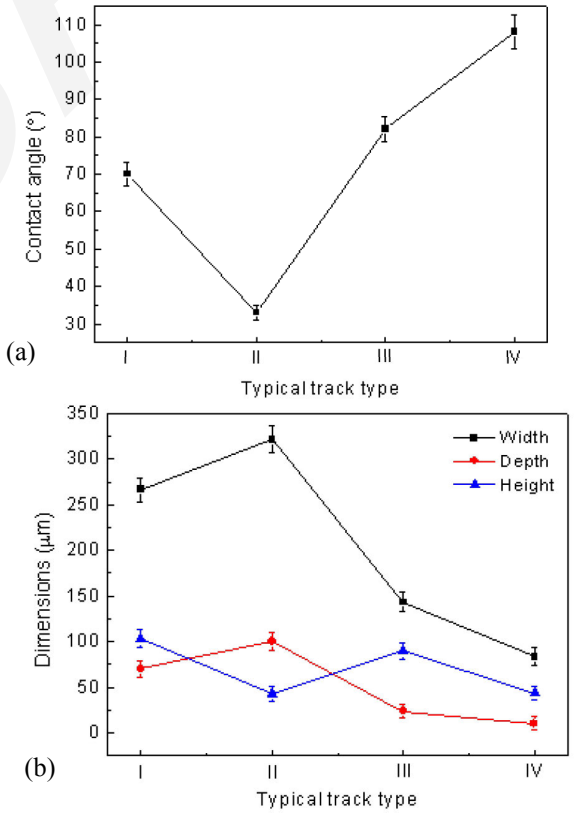


Fig. 4 Measurements of the cross-sections of the four typical single tracks: (a) contact angles on the surface processed previously; (b) dimensions of the cross-sections

Formation mechanisms of unfavorable typical tracks

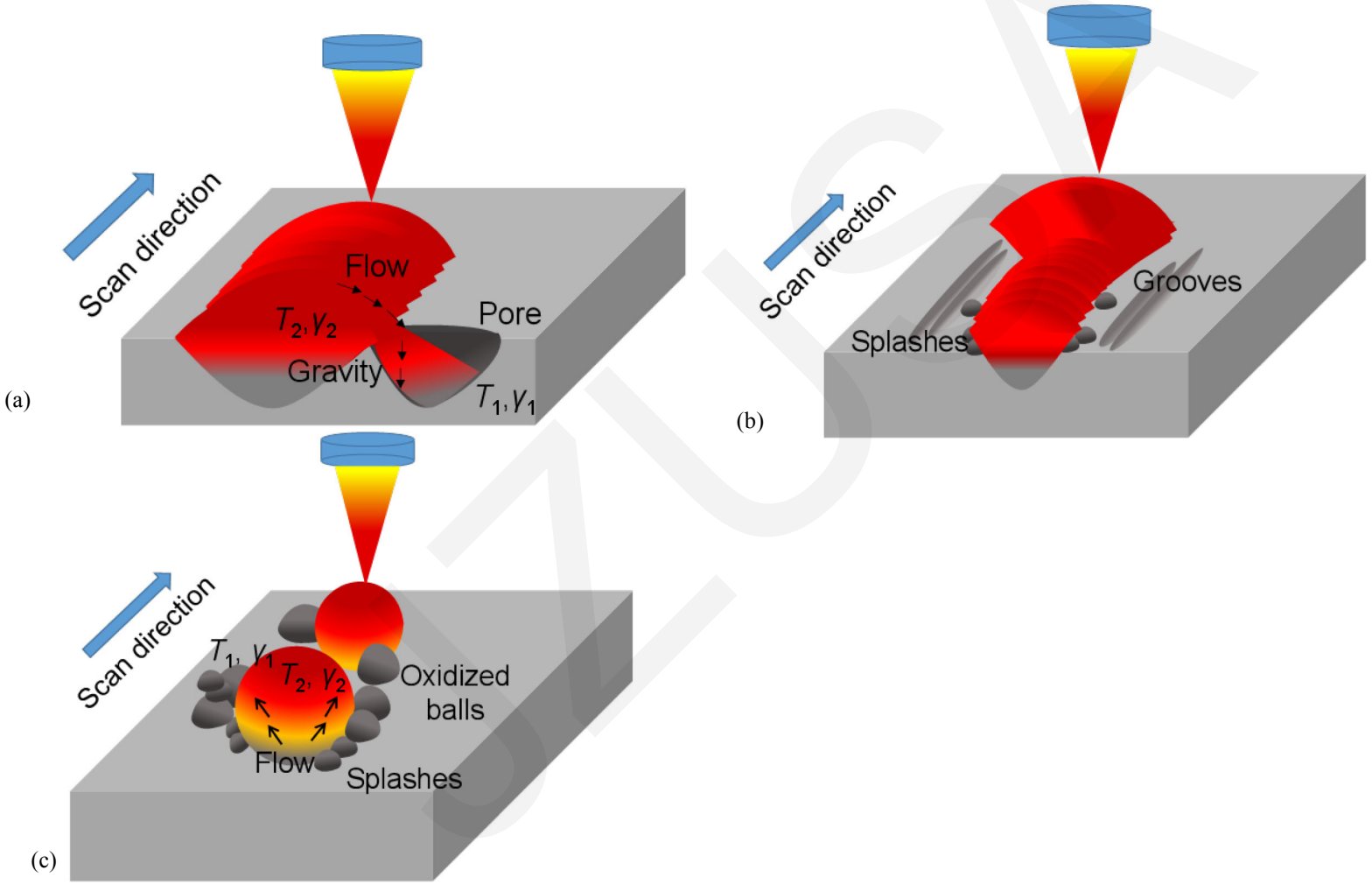


Fig. 5 Schematics of formation mechanism of three typical tracks on the substrates with various surface morphologies: (a) extension; (b) shrinkage of neck; (c) balling phenomenon of the single track

Conclusions

Samples were prepared under different processing conditions in order to obtain different top surface morphologies, where single tracks were produced using a fixed processing parameter to reveal the mechanism of the single track on different morphologies.

- When the single track was formed on the smooth and flat surface of the SLM sample, there was sufficient molten powder present and the good wettability promoted the formation of a regular single track.
- In the case of large pores near the single track, there was some powder accumulated in the pore. In addition, the gradients of gravity and the surface tension had a tendency to expel liquid from the pool to the pore. Thus, the single track extended .
- A small amount of molten metal of the single track on the uneven surface was expected to decrease the amount of melt for wetting the SLM sample. A neck shrinking of the single track occurred.
- The oxide films formed on the balls caused poor wetting on the substrate by molten metal. In addition, the temperature gradient of the molten metal had an influence on the flow direction. As a result, the single track had a tendency to form balls.