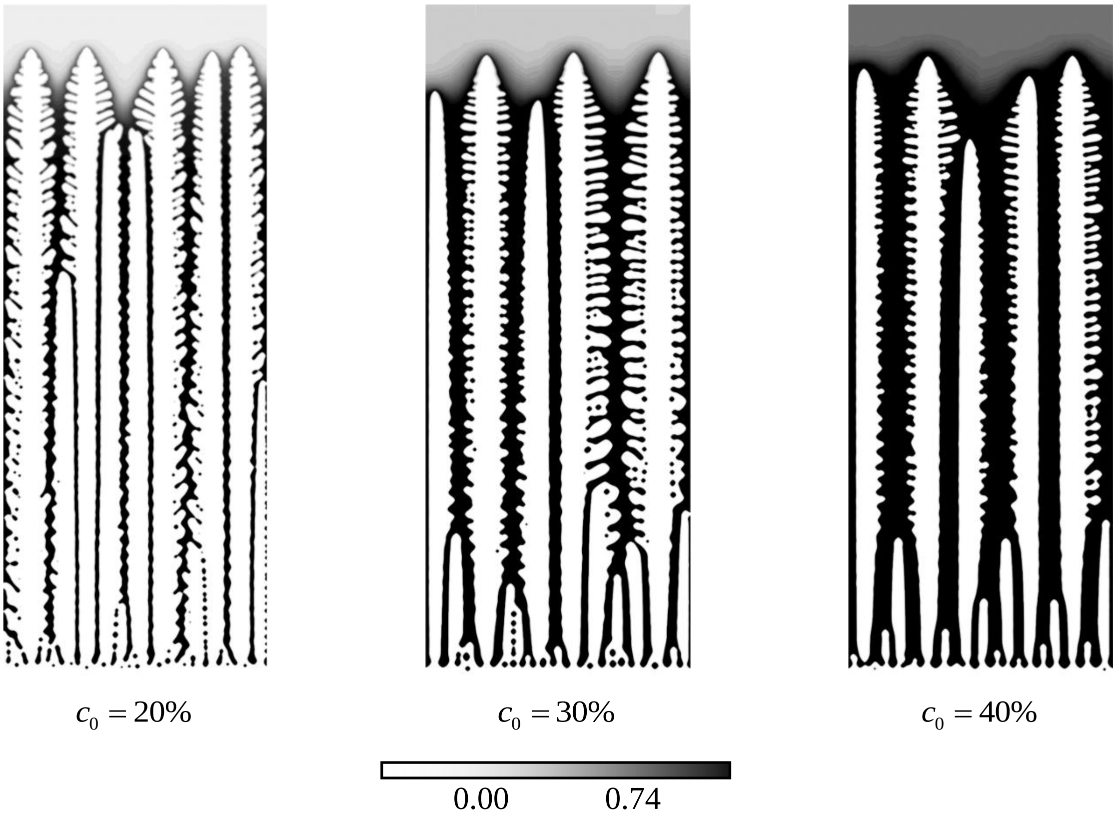

Fig. 1 Results of freeze casting simulation in 20%, 30% and 40% concentrations.

To further study the dendritic patterns on toughness, we choose three cases(case 1 to 3) to compare different shapes of dendrites (Fig. 3).Microstructures in these cases are taken directly from features in freeze casting microstructure to produce the RVE. Notice that, in order to maintain the criterion of these microstructures, the spatial density is kept in the same value.

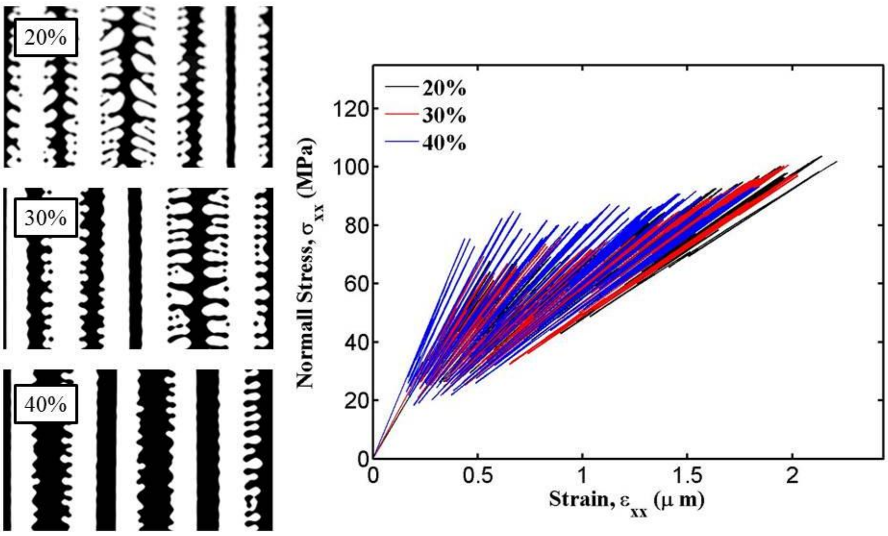

Fig. 2 Stress strain curve for different microstructures

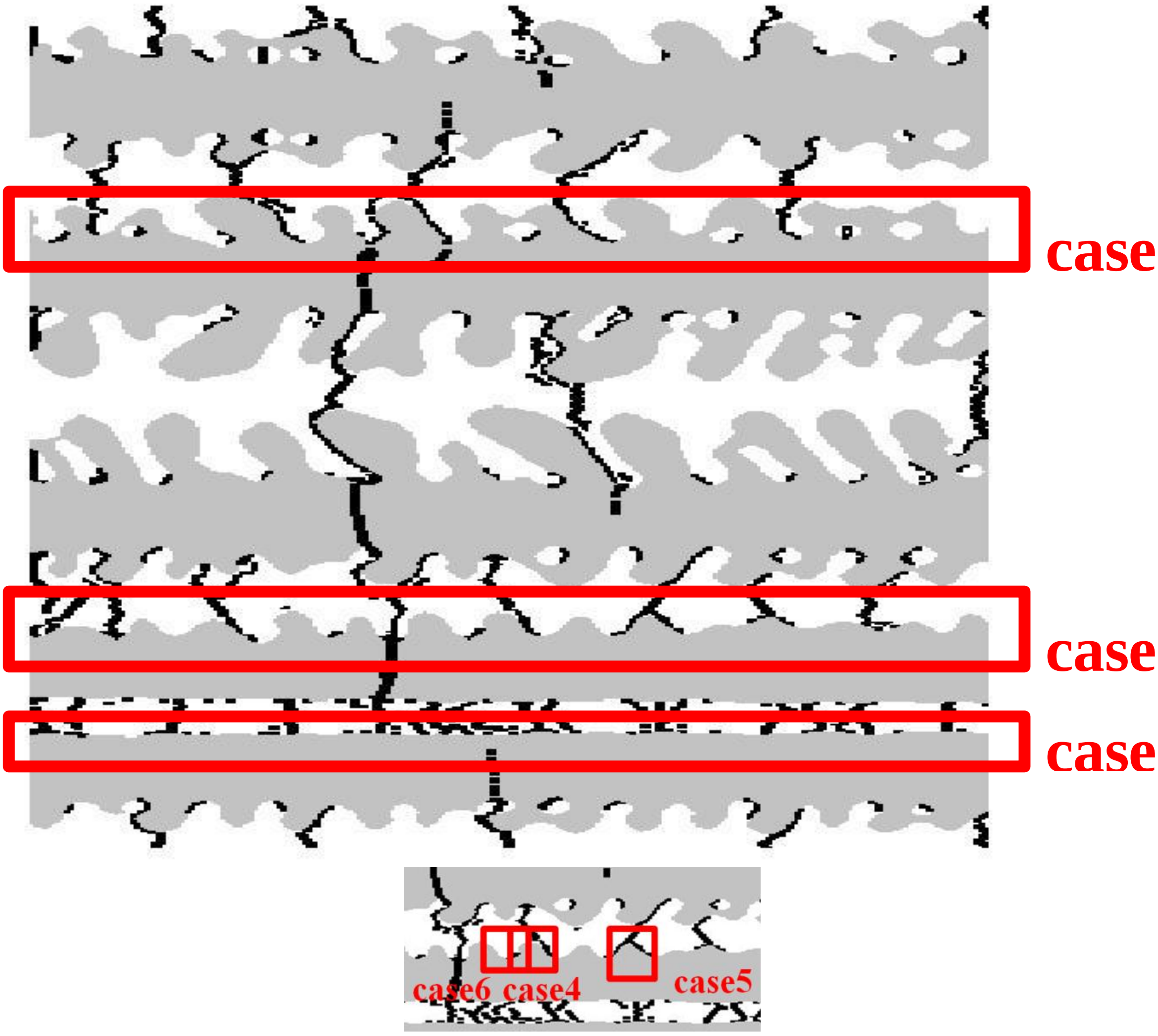

Fig. 3 Damage of the microstructure and the selected cases for further analysis

Left of Fig. 4 compares case 1 to 3 with the original freeze casting microstructure. It shows that dendrites do influence the property, but not all dendrite is beneficial for toughness, like case1.Case 3, which seems to process less dendrite, is actually tougher than the other cases. We notice that the case 2 does not fail at a sudden. It is implied that the shape of dendrites seems to be an important parameter. We thus further extract a single dendrite to explore the impact of shape.

By observing the crack development, we choose three cases (Fig. 3). The analysis results show that the shape of dendrites play an important role of toughness. Case 5 and case 6 process a better toughness comparing to case 3. (Fig. 4). All failure patterns are shown in Fig. 5.

Case 3 to 6

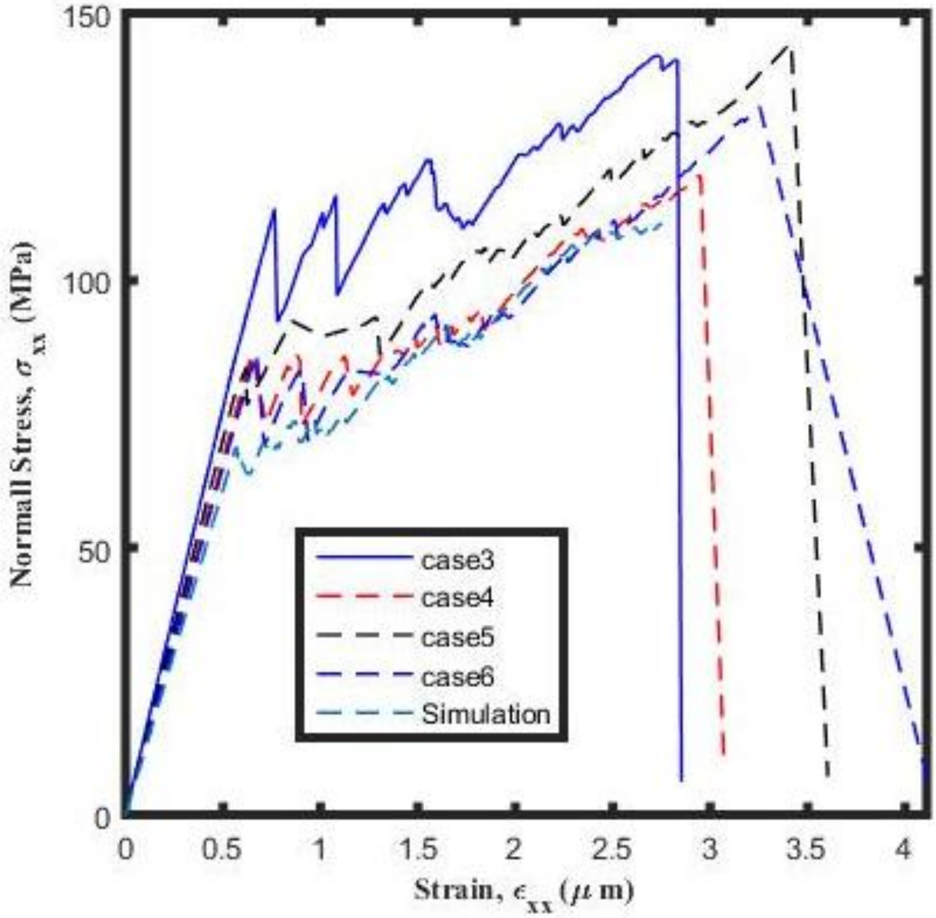

Fig. 4 Stress strain curve for six cases, including comparing first three cases with original freeze casting microstructure (left) and comparing last three cases with case 3.

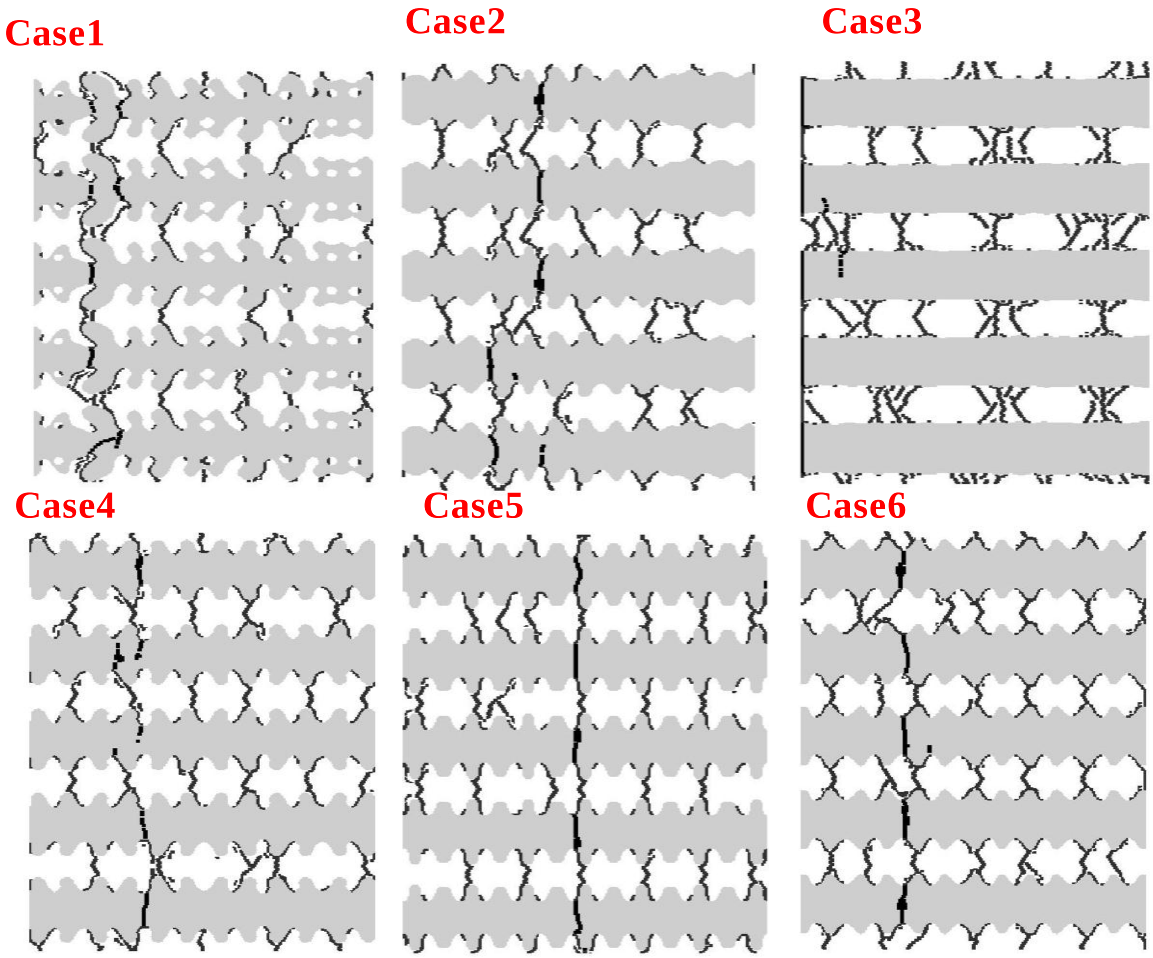

Fig. 5 Failure patterns of all the six cases studied herein.

4. CONCLUSION

In this study, a virtual processing for freeze casting based on a phase-field model is developed. A virtual testing adapting the concept of RVE is developed to investigate the stress distribution, load transmission as well as crack propagation due to different microstructures from freeze casting. We show that the level of dendrites is an important controlled parameter of the toughness. Furthermore, the dendritic patterns play an important role for toughness.

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