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Mechanical properties and optimization of AlNiCo magnetic materials fabricated by selective laser melting

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Introduction

SLM (selective laser melting) technology is a kind of **additive manufacturing** technology, which has advantages in making complex geometric shapes and lightweight structures.

There are many researchers studied AM with **magnetic materials**. It is of great significance to explore the theory and method of SLM for **AlNiCo** materials.

Objectives

We use SLM to fabricate parts from AlNiCo powder in order to research the effects of **laser process parameters** on **Mechanical properties**.

Materials

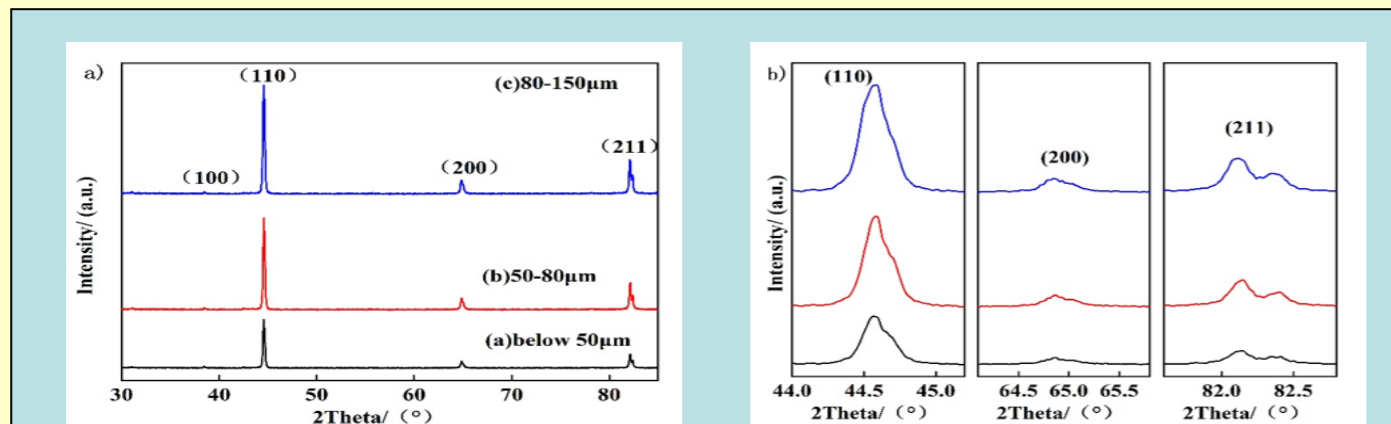


Fig. 1 The XRD pattern of AlNiCo powder with different particle sizes (a) XRD pattern (b) Magnified view of diffraction peaks on different surfaces

Results

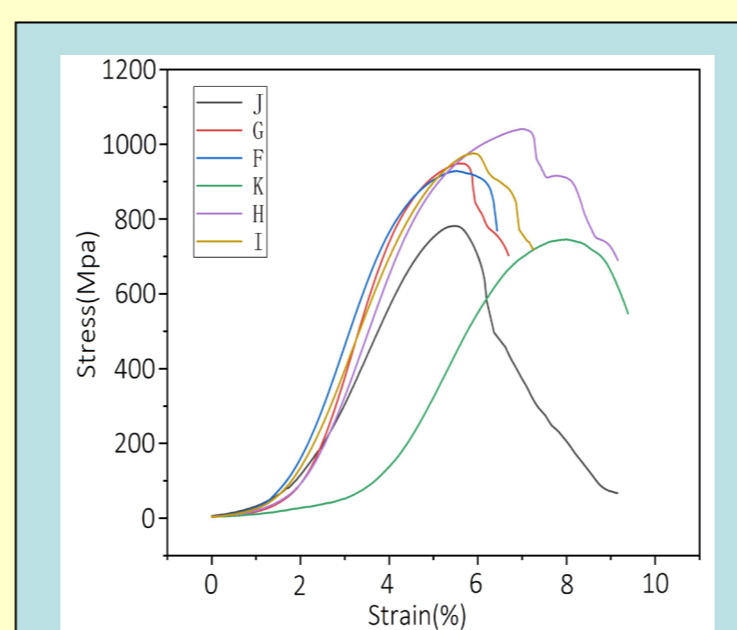


Fig. 2 The stress-strain curve of sample F-K

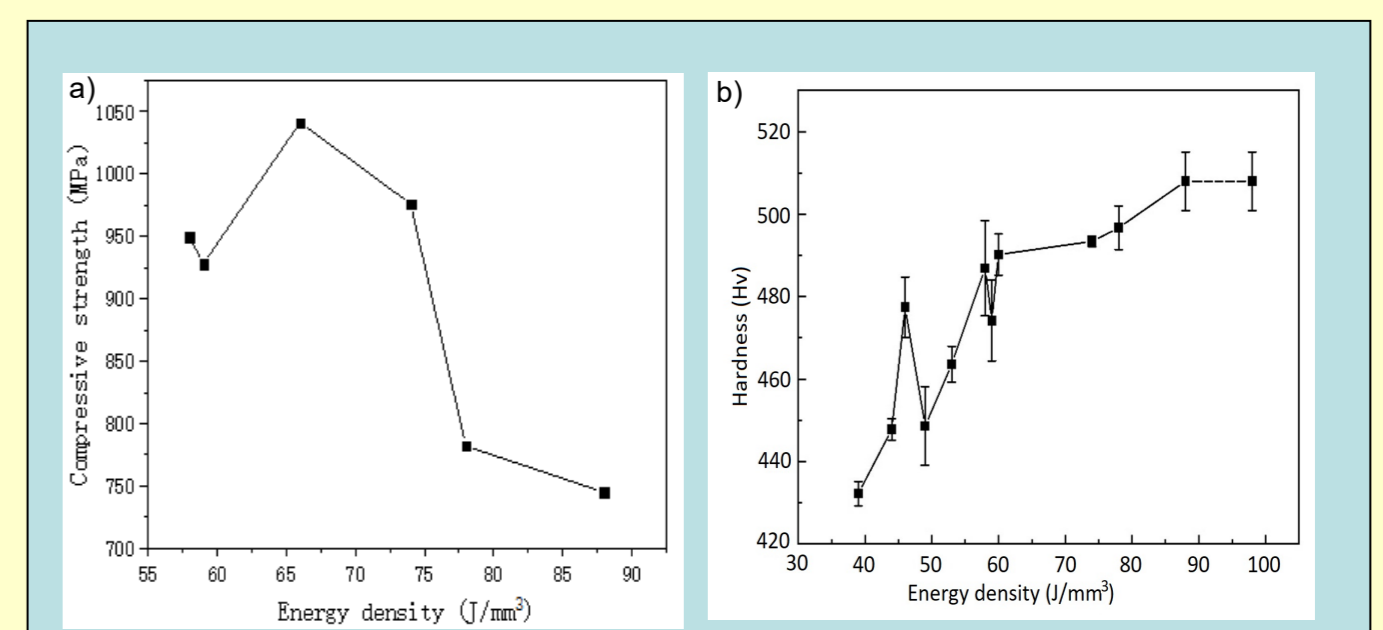


Fig. 3 Effect of laser energy density on (a) compressive strength and (b) microhardness

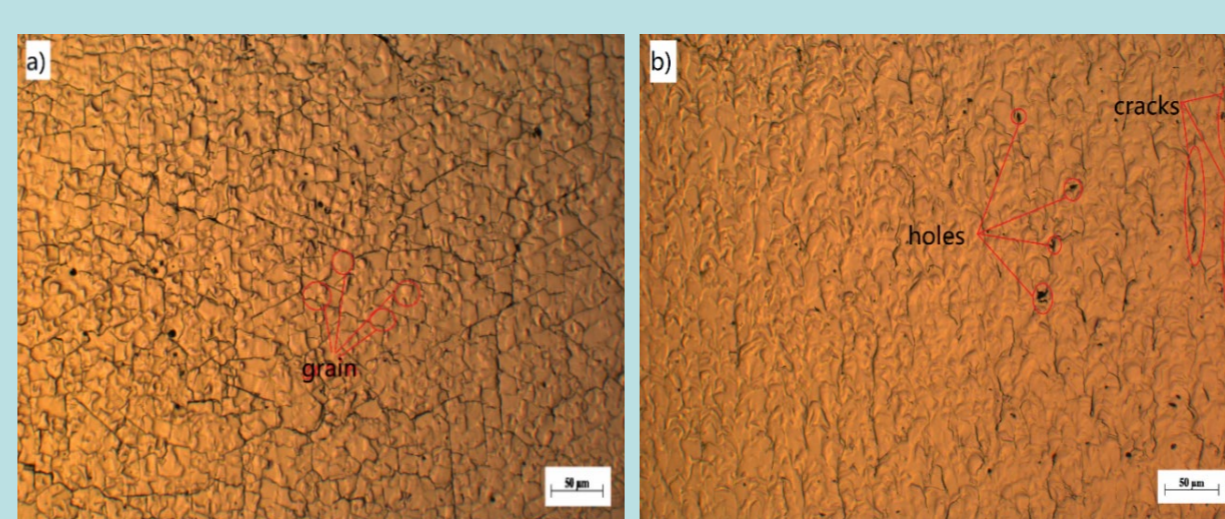


Fig. 4 The metallography of sample 'H' (a) xy-axis plane (b) z-axis plane

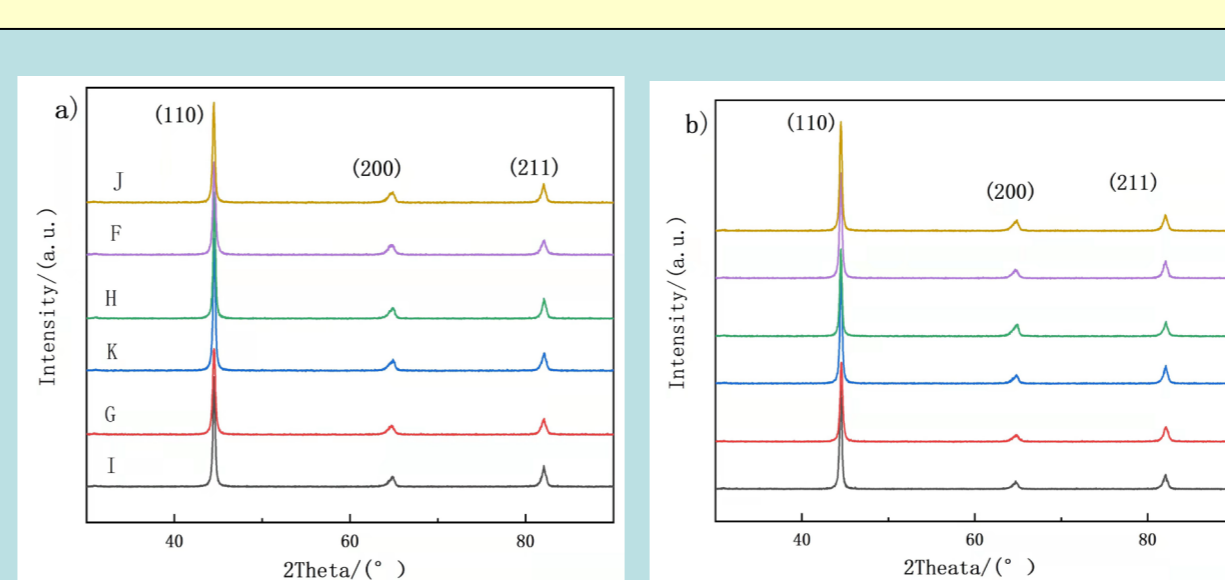


Fig. 5 XRD pattern of AlNiCo sample (a) xy-axis plane (b) z-axis plane

Tips:

- The laser energy density is given by:
$$\mu = \frac{p}{hvd}$$
Where p , h , v , d stand for laser power, scanning pitch, scanning speed and layer thickness.
- The sample F-K were fabricated by a metal 3D printer with different process parameters.
- The process parameters of sample H are $p = 170\text{W}$, $v = 800\text{ mm/s}$.

Summary

In this paper, SLM was used to study the fabricating of AlNiCo magnetic materials under laser power of 150~190 W and scanning speed of 400 mm/s~1200 mm/s. The mechanical properties and microstructure of the fabricated parts were studied and the following conclusions were reached:

- According to the experiments, the best process parameters of AlNiCo magnetic materials are listed as follows: the laser energy density area is 55-78 J /mm³, the scanning speed is 800 mm/s, and the laser power is 170 W.
- The compressive strength of AlNiCo samples fabricated in different process parameters ranged from 745 MPa to 1041 MPa. The Vickers hardness ranged from 432.2-508 HV.
- The microstructure of AlNiCo samples fabricated by SLM grew uniformly and the grains were fine. The grains were directionally solidified dendritic crystals with the uniform arrangement.
- It is proved that the SLM preparation of AlNiCo is a promising processing method in maintaining magnetic properties to reduce processing costs and material waste.