Experimental analysis of repairing H14 die steel surface by laser cladding

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Abstract: The damage of die metal parts is one of the key problems that affect its normal use. Laser cladding technology can solve this problem quickly and effectively. In this paper, the tungsten alloy powder was cladding on the metal surface by laser cladding, and the surface repair and strengthening technology were carried out. The influence of laser scanning speed on the microstructure of cladding layer metal was studied. The experimental results show that the metal parts with surface damage are repaired by laser cladding technology, and the cermet protective layer without pores and cracks is obtained. The hardness value of laser cladding layer is greatly improved than that of base material, which lays a good foundation for improving material performance.

1. Introduction
Mold is the key and important equipment in the large machinery industry. If the die is worn or damaged due to various problems, it may lead to huge economic and technical losses. The first way to improve the die surface durability is to strengthen the metal surface[1,3].

According to the literature description, at present, mold enterprises basically use thermal spraying, welding and surfacing to strengthen the damaged mold surface. Each of the three technologies has its own advantages and disadvantages[2]. Compared with laser cladding technology, laser cladding technology has many advantages, such as fast setting speed, good fusion degree with substrate, low thermal effect, and the cladding powder can be selected according to the needs of the processed parts, which has a broad prospect in the field of mold repair and surface strengthening.

In this paper, aiming at the serious wear marks and cracks in cold stamping die, the effect of laser scanning speed on the microstructure of cladding metal was studied. The alloy coating with high mass fraction, low dilution ratio and good adhesion with H14 die steel was obtained[4]. The good surface repair and strengthening effect of the alloy coating were obtained.

2. Research Equipment

2.1 selection of cladding materials
H14 die steel was selected as base material, NiCrBSi alloy powder was selected as cladding material after a series of surface treatment[5].

2.2 analysis equipment
The changes of microstructure and morphology of cladding layer were analyzed by SONY TD material image analysis system and its special scanning electron microscope and energy spectrum.
microhardness distribution of the cladding layer was measured by XS-1000 digital microhardness tester.

3. Research Process
(1) The alloy powder with good configuration is loaded into the automatic powder feeder;
(2) The nozzle of the automatic powder feeding device is positioned at the damaged part of the tested mold, and the relevant equipment is adjusted and the moving position is set;
(3) Start the test equipment, and send the metal powder into the molten pool in the laser cladding area through the nozzle in the automatic powder feeding device[5,6]. When the laser is turned off, the molten alloy powder quickly condenses and forms a coating on the surface of the tested component;
(4) After the first cladding process, the automatic powder feeding device is moved to make the sprayed metal powder reach the required area;
(5) The required surface roughness can be obtained by milling and grinding the coating.

4. Results and Analysis

Figure 1 Comparison before and after laser cladding

Figure 1 shows the comparison of the test mold before and after laser cladding. It can be concluded that there are serious wear, pits and cracks in the test mold before and after the repair, and the maximum depth of the pit is 1.1 mm. After multi-layer laser cladding, the surface of the repaired area is smooth and smooth. After the inspection of relevant equipment, there are no pores and cracks on the repaired surface.

Figure 2 Structure of the cladding layer

Figure 2 shows the microstructure of the cladding layer formed on the surface of the repaired part after laser cladding, which shows that the dilution ratio of the cladding layer is larger. The cladding time has a close relationship with the microstructure of the cladding layer, which is determined by the rapid solidification characteristics of the internal materials of the coating. Of course, it is related to the cooling rate of laser processing and the realized temperature gradient. Table 1 shows the comparison of hardness values of laser cladding layer under different action time.

| Action time (s) | Hardness of cladding layer (HV) | Distance from maximum hardness point to |
|----------------|----------------------------------|----------------------------------------|


It can be seen from table 1 that with the change of laser cladding time, the hardness of the cladding layer also changes. Basically, the hardness value of the cladding layer begins to decrease with the increase of the action time. The average hardness of cladding layer is 608.2hv, which is 2.31 times higher than that of 262.8hv in original state.

5. Conclusion
In this paper, suitable laser cladding parameters and cladding materials with good properties are selected to form a low dilution and good effect alloy cladding layer on the surface of the tested mold. The average hardness of the cladding layer is 608.2hv, which is 2.31 times higher than that of the substrate.

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