Powder Selection Scheme for Laser Deposition of High Entropy Alloys

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Abstract. According to the published literature, there are three types of laser-clad over-enriched alloy formulations on the surface of aluminum alloys, AlCrFeCoNi, AlCrMnFeCoSi, AlMnFeZnSi. AlCrFeCoNi coating was prepared on the surface of aluminum alloy by the University of Texas in the United States in 2015. It is pointed out in the paper that this component is the best quality formula among many high-entropy alloys. The process experiment is characterized by water-soluble organic The suspension was made into a suspension and then spread on the surface of the aluminum alloy using an air-spar technique and cladding with a YAG laser. This paper mainly studies the powder experimental scheme of noble alloy layer on aluminum alloy surface.

1. Introduction

High-entropy alloys break through traditional alloys with one or two elements. The design idea of the alloy of the principal element is close to the equimolar ratio (the erby is at5%~35%Scope), multiple (5Kind and above) alloying. Due to the high entropy effect, it has much lower equilibrium phase. The predicted number of phases is a simple solid solution structure, while the alloy passes alloying and processing to form a new fiber structure with excellent properties, high strength, high hardness, high temperature oxidation resistance, good wear resistance and corrosion resistance. High entropy alloy may break through the performance of traditional metal materials limit, meet the higher demand for materials in industrial technology development, and have a broad development prospect.

AlxCoCrCuFeNi alloy has a simple solid solutionBody structure and some excellent properties, and for the first time proposed a high entropy alloy concept AlCoCrCuFeNi High-entropy alloys have become the focus of research, Such as microstructure, mechanical properties, corrosion resistance, thermal stability and magnetism performance, as well as elemental proportion, doping, aging. The impact of energy and AlCoCrCuFe High-entropy alloy literature reports relativeless. Mechanical alloying and discharge plasma sintering preparation AlCoCrCuFe evolution of the alloy phase, prepared by the former alloy BCC of FCC phase composition, grain size is 10 nm left and right; the latter prepared more samples Phase, grain size is about 74nm. Qiu In order to ensure that the combination of elements can
form a high-entropy alloy phase structure, namely BCC, FCC crystal structure, the metal elements are theoretically screened:

AlCoCrCuFe microstructure alloy has corrosion resistance, and pointed out the microstructure of the alloy prepared by rapid solidification the structure is much smaller and the alloy is evolution of the alloy phase

2. Method and conclusion
In order to ensure that the combination of elements can form a high-entropy alloy phase structure, namely BCC, FCC crystal structure, the 15 metal elements are theoretically screened

2.1. Select the element's atomic radius to be close.
AlCrFeCoNi coating was prepared on the surface of aluminum alloy by the University of Texas in the United States in 2015. It is pointed out in the paper that this component is the best quality formula among many high-entropy alloys. The process experiment is characterized by water-soluble organic The suspension was made into a suspension and then spread on the surface of the aluminum alloy using an air-spart technique and cladding with a YAG laser. A total of two SCI articles were published in this experiment to analyze corrosion performance and microstructure evolution, but there were cracks on the coatings analyzed in the scanning electron micrographs. According to the conditions of our laboratory, if the processing can be processed by the coaxial feeding process, the steps of the air-spart technique can be simplified, and the addition of different contents of Al can be performed once with the same powder, which can be used as a basic experiment; AlCrMnFeCoSi, AlMnFeZnSi is the master's thesis of Huang Can, which is the main reason for the improvement of coating quality, such as wear resistance and corrosion resistance.

2.2. Select the element's atomic radius to be close.
Most of the constituent elements should have atomic radii close to each other with a radius difference of no more than 15 percent. This is recognized as the core principle that can constitute a high-entropy alloy phase structure. The atomic radii of the elements in the same period are similar. It is necessary to select within 15 elements. The elements of the fourth period, Cr, Mn, Fe, Co, Ni, and Cu, are most suitable. This also confirms why more than 98% of high-entropy alloy articles are based on these elements.

It can choose more powder formulas and combinations. For example, the powder contains Mo, V, Nb, etc. They are all 2000 degrees. The element of the melting point, but adding a high melting point powder to the aluminum alloy will increase the dilution rate, so the addition should be cautious.

The addition of elemental rare earth lanthanum can refine the grain and improve the quality of the coating. The melting point of lanthanum is about 1500 degrees, which can be considered for addition.

2.3. The principle of mixing absolute value as much as 0.
The excessively mixed enthalpy between the two elements means that the ability to form intermetallic compounds between the elements is strong. For example, the Al-Ni mixed mixed enthalpy is -22, so the high-entropy alloy synthesized in many literatures has Al-Ni metal. Intermetallic compound, this intermetallic compound is characterized by hard and brittleness, a small amount can increase the hardness, improve the coating quality, a large amount will reduce the wear resistance of the coating, cracking, and lead to weakening of the coating and substrate bonding, and even cracking. Therefore, if the mixing between the two elements is low, the choice should be cautious, and the amount of addition should be controlled.

2.4. The synthetic elements should be between 4 and 7
High-entropy alloys are characterized by a large number of synthetic elements, resulting in a high-entropy alloy effect (theoretically, the more elements, the greater the probability of forming a solid solution, the lower the probability of forming a brittle metal compound) and the cocktail effect.
Therefore, when formula selection, the element should be greater than 4 to distinguish from the traditional alloy and increase the mixing entropy of the alloy. When the alloying elements reach 7 pieces, according to the existing papers, the phase structure appears to be more complicated, and the analysis is more difficult, and as a material for coating modification, there is no obvious advantage compared with the combination of elements below 7 elements, and the cost is increased. And the difficulty of operation, so I don't plan on more than 7 recipes. The selected elements are between 4-7.

At present, in the performance study of high-entropy alloys, the main focus is on thermal stability, compression properties, etc. And about high-entropy alloy erosion research on performance is still relatively small. Arc melting is commonly used at home and abroad. High-entropy alloy block. But because of the composition of the high-entropy alloy

Many precious metals lead to higher costs for bulk high-entropy alloy. Therefore, Spark plasma sintering (SPS) technology, preparation AlxFeCr-NiCoCu (x = 0, 1, 2, 3) high-entropy alloy coating and exploration Al Element pair SPS. Effect of microstructure and erosion performance of prepared high entropy alloy coating.

3. Problems and Prospects in Research of 4 High Entropy Alloy Cladding Coatings

3.1. Formation mechanism and phase formation mechanism of high-entropy alloys.
Because of the large number of principal components in high-entropy alloys, it is not accurate to analyze the mechanism of condensation process by phase diagram. It can not be explained by Gibbs law of phase transition p = n + 1. At present, some scholars have preliminarily studied the formation criteria of mechanical alloying phase formation and high temperature solid solution phase formation. Reaction diffusion in solid state preliminarily explains the phase formation kinetics of mechanical alloying. Zhang Yong of Beijing University of Science and Technology put forward the solid solution criterion theory and the entropy action criterion theory through a large number of experimental data analysis. When the composition of the alloy is less than 6.6% and is greater than 1.1, a high-entropy alloy can be formed between the multi-principal components. However, there are still many gaps in the study of the mechanism of alloying process of high-entropy alloys. There is still much room for improvement in the phase diagram, thermodynamic and dynamic analysis of high-entropy alloys.

3.2. The choice of laser cladding high-entropy alloy substrate is single, and the high-entropy alloy coating with special properties needs to be designed and studied.
At present, most of the research substrates are focused on Fe substrates such as Q235 and 45# steel. Steel is currently the most widely used engineering materials, whether it is bridges, buildings, or large equipment, small parts, all have the shadow of Fe. Zhang Airong et al. AlCrCoFeNiMoTi0.75Si0.25 high-entropy alloy tool coating was prepared by laser cladding technology. The main phase structure of the coating is BCC hard phase, and the coating still has good stability at high temperature. Compared with high-speed steel, high-entropy laser cladding coated tool has higher surface hardness, smaller friction factor and better chip breaking effect. However, there are few studies on laser cladding of high-entropy alloy coatings on Al, Cu, Ni and Co substrates. Ferrium-based materials are rarely used in aerospace, electronic devices and magnetic devices. Therefore, it is necessary to study the physical and chemical properties of high entropy alloy coatings on Al, Cu, Ni and Co substrates. At present, some researchers have developed high-entropy alloys with anisotropic soft magnetism and high resistivity, which have great application value in high-frequency communication devices [13]. Others have developed high-entropy hydride secondary batteries, which provide ideas for solving the problem of hydrogen storage materials [14].

4. Conclusion
Multi-principal high-entropy alloys exhibit different properties than traditional alloys. Sex and a wide variety of new elements to get a new variety Type alloys therefore have a wide range of applications and a wide range of applications However, the current research on the mechanism of the formation process
of high-entropy alloys is still less, some of the existing high-entropy alloy systems are just passing. The so-called cocktail-style method is a combination of research. Microstructure and hardness of medium-high entropy alloy wear resistance corrosion resistance. There is no scientific theory that guides the choice of alloying elements. Further research is needed on the microstructure of high-entropy alloys. Analytical and electrochemical properties. Determination of magnetic properties to establish alloying elements selection theory, solidification crystallization theory, heat treatment theory, etc. The method for preparing high-entropy alloys mainly includes fusion casting method and powder metallurgy method. As the research progresses, some new methods such as vacuum coating can also be used to prepare high-entropy alloys. In summary, high-entropy alloys are a

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