coatings

Supplementary Materials: Fabrication and Characterization of Ni60A Alloy Coating on Copper Pipe by Plasma Cladding with Induction Heating

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1. Our Group's Previous Research on Copper Plate

In our group's previous research, the effect of preheating temperature on the quality of Ni60A coating was studied. Figure S1 shows the appearance of Ni60A coating on copper plate by plasma cladding under different preheating temperatures. With the increase of preheating temperature, the state of the coatings showed a transition law of directly peeled off (room temperature) → discontinuous and spherical (below 500 °C) → continuous and uniform (600 °C) → continuous but uneven (700–800 °C). It can be concluded that the preheating temperature of about 600 °C is appropriate for plasma cladding on copper surface.

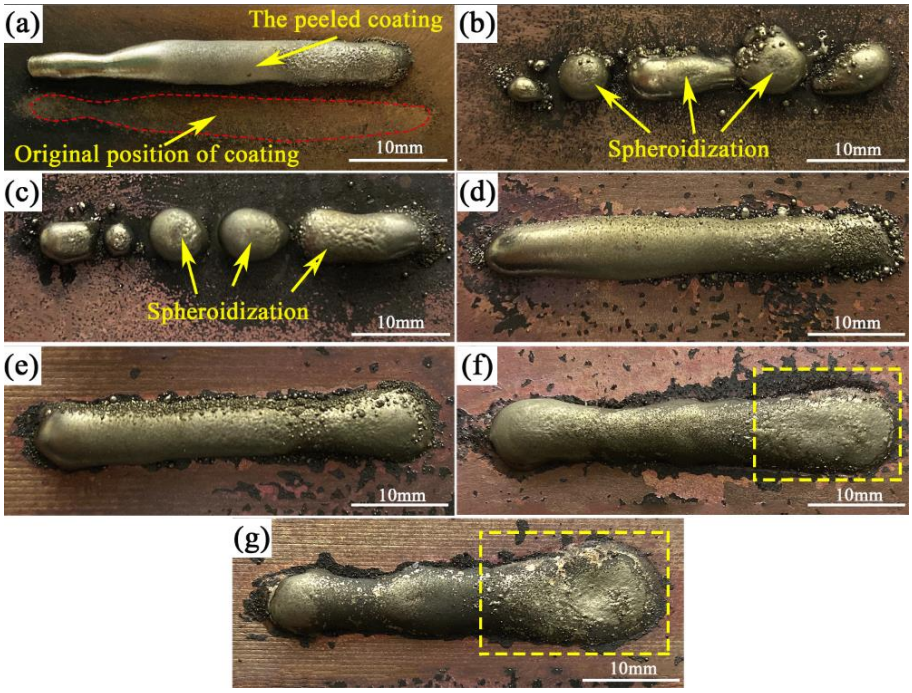

Figure S1. Appearance of Ni60A coatings on copper plate under different preheating temperature: (**a**) room temperature, (**b**) 300 °C, (**c**) 400 °C, (**d**) 500 °C, (**e**) 600 °C, (**f**) 700 °C and (**g**) 800 °C.

2. Ni60A Alloy Powder

Figure S2 shows the SEM morphology of Ni60A alloy powder. It can be seen that the powder has a spherical shape with a size of 45–100 μm.

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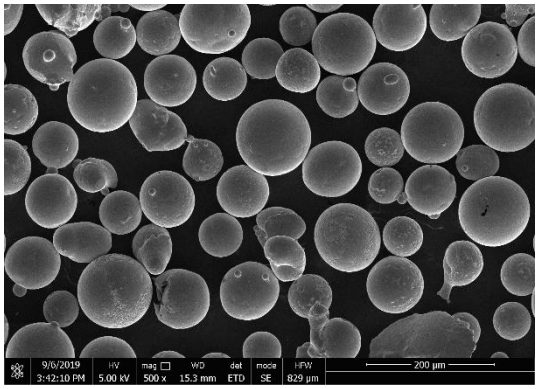

Figure S2. The SEM morphology of the Ni60A alloy powder.

3. Schematic Diagram of the Wear Test Process

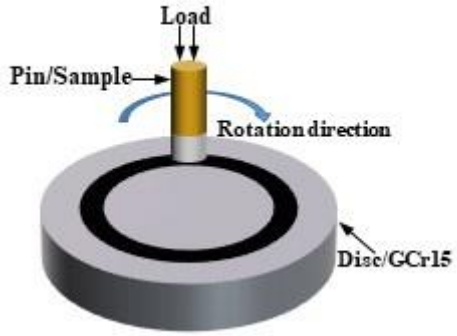

Figure S3. Schematic diagram of the wear test process.

4. Calculation Method of Cladding Efficiency

As shown in Figure 2b, the cladding efficiency can be expressed as:

$$\eta = \frac{LW}{\frac{L}{v}} \quad (1)$$

$$L = \pi D \quad (2)$$

Where the η is the cladding efficiency, D is the diameter of the copper tube, L is the length of a circle along the copper pipe, W is the width of coating and v is the rotating speed of copper pipe. It can be calculated that the cladding efficiency of the coating mentioned in the original manuscript is 32.72 mm²/s.

In addition, a single-track Ni60A coating was prepared on copper pipe by cladding parameters in Table S1 (the swing arc program was removed), as shown in Figure S4. The width (W) is about 5.5 mm and the length (L) is about 157.08 mm. According to the Equation (1) and Equation (2), its cladding efficiency is only about 12 mm²/s.

Figure S4. Appearance of single-track Ni60A coating on copper pipe.

Table S1. Parameters of single-track plasma cladding process.

Parameter	Value
Preheating temperature (°C)	600
Rotating speed of copper pipe (mm/s)	2.18
Current (A)	140
Powder feeding speed (g/min)	19.74
Nozzle distance (mm)	10
Plasma gas flow rate (L/min)	3
Shielding gas flow rate (L/min)	9
Powder feeding gas rate (L/min)	3

5. SEM Magnified Micrograph of Ni60A Coating

Figure S5 shows the magnified SEM morphology of Figure 6a. The microstructure of phases can be observed more clearly in this morphology.

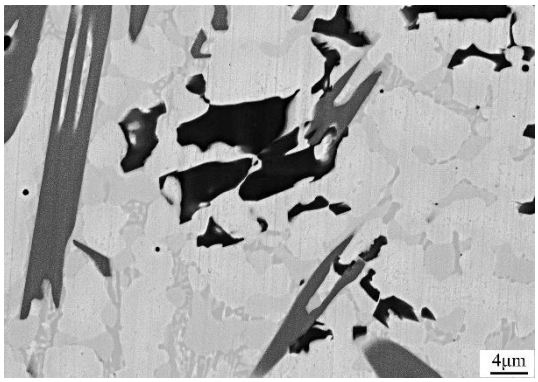

Figure S5. SEM micrograph of Ni60A coating.

6. EDS Mappings on the Cross-Sectional Images throughout the Coating Thickness.

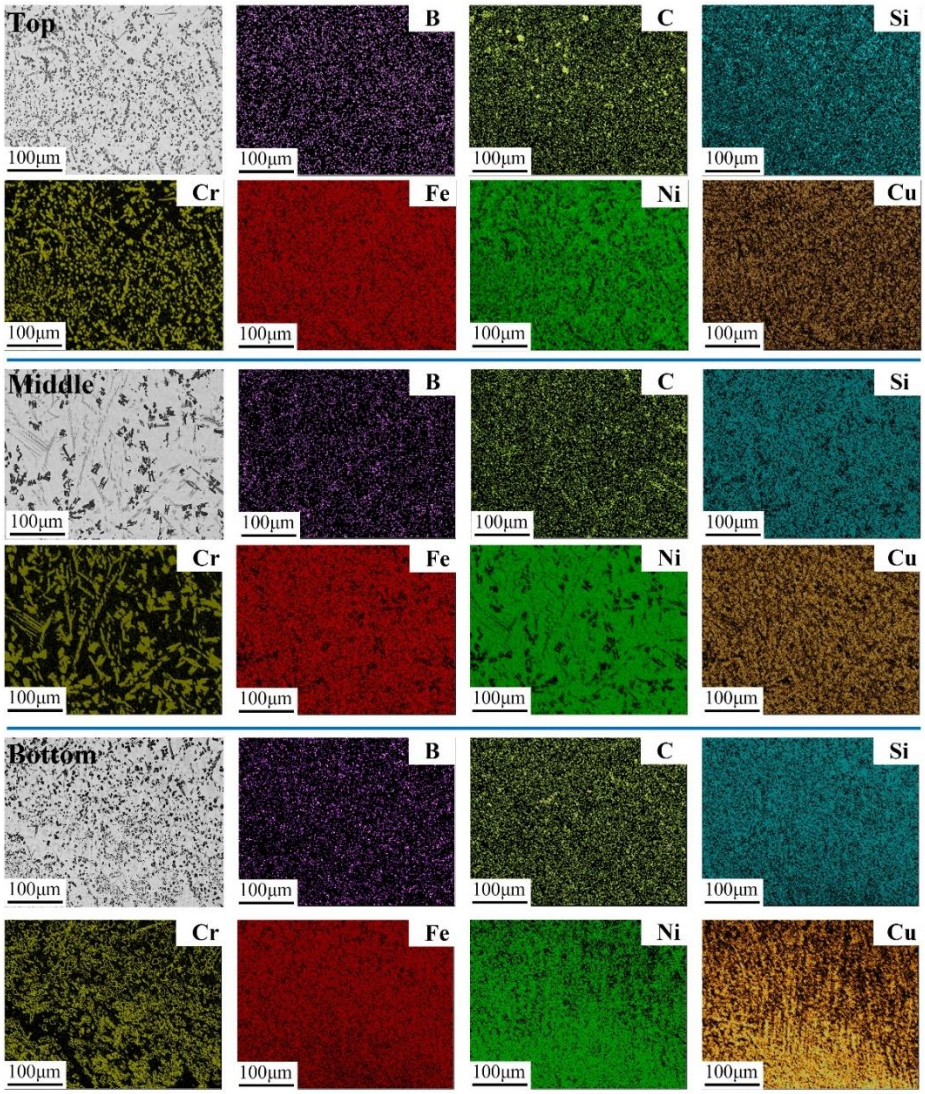

Figure S6. Cross-section SEM micrograph and the elemental mappings of cross-section of the Ni60A coating (S3).