ABSTRACT OF DOCTORAL THESIS

Full name of PhD candidate**: Xuan Cuong Ngo**

Thesis title: ***"Research on plasma spraying technology for fabrication of silicon carbide plasma coating on steel surface to protect against corrosion in the fluorine-containing acidic medium"***

Major: Mechanical Engineering

Training code: 9520103

Full name of the scientific supervisors:

1. Dr. Ha Tuan Nguyen

2. Dr. Tuan Anh Nguyen

Institution of education: National Research Institute of Mechanical Engineering– Ministry of Industry and Trade

KEY CONTENTS OF THE THESIS

1. Aims and objectives of the thesis

a) Aims of thesis

- Create SiC-Cu plasma coating on steel surface.

- Research on some important properties of SiC-Cu plasma coating technology on steel surface to apply anti-corrosion protection for machine parts working in HF-containing environments.

b) Objectives of the thesis

Investigate the influence of 3 parameters : current I, injection interval L, powder feed flow M on the quality of plasma coating based on SiC on steel surface.

c) Research scope.

Research on technology to create SiC-Cu plasma coating on steel to protect against wear for machine parts working in fluorine-containing acid environments: evaluation evaluate some typical criteria and influence of plasma spray coating technology parameters on coating quality to establish a set of technological parameters for creating SiC - Cu coating on steel base, including:

- *The basic criteria of the coating that need to be surveyed and evaluated:*

+ Coating thickness

+ Adhesion strength.

+ Porosity.

+ Micro hardness.

+ Corrosion resistance of coatings in acidic environments containing fluorine.

- *Main influencing technology parameters:*

+ Spray particle size - W (µ m).

+ Mixing ratio of flour (content of powder ingredients) - S (%).

+ Amperage - I (A).

+ Spray distance - L (mm).

+ Powder feeding speed - M (g/min).

2. Research Methods rescue

Combination of theorystudy and experimentals.

Theoretical study

- An overview study on plasma spraying technology and coating formation process
- Research on experimental planning methods to process data using Taguchi's experimental planning plan, using ANOVA to evaluate the relationship between technological parameters and achieved quality criteria..

Experimentals:

- Design experimental models based on analysis of plasma spray technology parameters to coating properties based on studies of previous publications and exploratory experiments.

- Improved method of spraying in Ar shielding gas; design, manufacture protective gas shield, design and manufacture samples to test adhesion strength for.

- Design and manufacture composite wear test equipment according to actual conditions

- Spray experimental samples

- Analysis of coating cross-sectional organization by scanning electron microscopy, phase composition analysis by X-ray diffraction method

- Evaluation of the quality of the coating includes:

+ Coating thickness

+ Adhesion strength.

+ Porosity.

+ Micro hardness.

+ SiC content in the coating

+ Corrosion resistance of coatings in acidic environments containing fluorine.

- Based on experimental results and analysis of variance, combining multi-objective regression to evaluate research results according to set objectives.

- Coating finish with PTFE penetration (PTFE/SiC-50Cu) for synthetic wear testing and assessment

3. Contents of the thesis

Chapter 1: Overview of anti-corrosion thermal coatings

Chapter 2: Technology to make SiC plasma coating on steel base

Chapter 3: Materials and research methods

Chapter 4: Fabrication, analysis and evaluation of SiC plasma coatings on steel substrates

Chapter 5: Determination of technological parameters for SiC-50Cu plasma spraying on C45 steel substrates

4. New findings of the thesis

- This is the first project in Vietnam to study the technology of creating SiC/Cu plasma coating on steel surface.

- Improved method of plasma spraying technology in the air by plasma spraying in Ar shielding gas.

- Finishing SiC/Cu coating on steel surface by PTFE penetration.

- Design and manufacture of composite wear equipment to provide a method of synthetic wear assessment.

5. Conclusions of the thesis

*. This is the first project in Vietnam to successfully research the technology of creating SiC/Cu plasma coating on steel surface.

*. Determining reasonable powder parameters (mixing ratio, SiC, Cu particle size) and successfully fabricating SiC-30Cu coating; SiC-50Cu on C45 steel by plasma spraying method with required thickness (200 µm) and SiC composition as high as 71%.

*. Improved method of plasma spraying technology: Design and manufacture of Ar gas shield to protect the plasma spray stream, leading to when spraying on C45 steel with SiC-30Cu and SiC-50Cu, achieving coating quality criteria:

- Coating thickness: 204.67 ± 26.5 µm and 220 ± 20.5 µm.

- Low porosity: 1.4%.

- SiC composition in the coating achieved: 53%.

Finishing SiC/Cu coating on steel surface with PTFE penetrant to overcome porosity improving corrosion protection.

*. Design and manufacture a set of mixed wear test equipment according to actual conditions (sampling speed in abrasive grains 1000 v/min; acid mixture 10% HF; 20% H2SO4 at a temperature of 70ºC) to provides an integrated wear assessment method for weight loss over time.

*. The results of measuring corrosion protection for C45 steel when using 3.5% NaCl solution of SiC-Cu composite coating systems with or without PTFE penetration show that the two coating systems are SiC. -50Cu and PTFE/SiC-50Cu both strongly reduced the corrosion current of C45 steel from 9.44 to 5.6 and 0.59 µA/cm2. With PTFE/SiC-50Cu permeable coating increases the polarization resistance of C45 steel by nearly 370 times, which increases the effectiveness of corrosion protection.

*. The mass loss measurement results after 136 hours of testing in mixed wear test equipment show that the SiC-50Cu/steel or PTFE/SiC-50Cu/steel test pieces have very low loss mass, respectively. are 503 mg and 156mg, much lower than that of stainless steel SUS304 (7809mg).

*. Experimental research has been carried out using the 3^3 fully orthogonal planning method to evaluate the influence of the spray technology parameters I, L, M on the coating quality parameters and the ratio. SiC ratio in the coating. Analyzing and identifying experimental regression functions that allow to evaluate the influence of technological parameters I, L, M on each indicator and group of criteria. The set of technological parameters for plasma spraying to create SiC-50Cu coating while achieving high adhesion strength, low porosity, hardness and high SiC content in the coating are:

I=416A, L=45mm và M=32 g/min.

*. PTFE/SiC-50Cu plasma coating is a coating that can be applied for corrosion

protection of C45 steel in acidic fluorine environments.

Hanoi, March 20 , 202 3

Scientific supervisors **Study born**

Dr. Ha Tuan Nguyen **Dr. Tuan Anh Nguyen** **Xuan Cuong Ngo**