Research on Recognition Method of Coating Composition Based on Spectral Image

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Abstract: In traditional methods, X-ray detection method is mainly used to identify coating composition. The principle of this method is complex, and it cannot be accurately identified when the coating is seriously oxidized. A design method of coating composition recognition system based on spectral image analysis is proposed. Firstly, the principle is analyzed, and the hardware design of coating composition recognition and detection system is carried out by ADSP21160 processor. The software design uses laser infrared imaging algorithm to image and collect the spectral image of electroplated coating, uses wavelet decomposition to separate and process the noise of the spectral image, realizes feature extraction, identifies the composition of the coating through feature analysis, and develops software and system on Visual DSP+4.5 platform. The simulation results show that the method can accurately detect the composition and content of the coating and has superior performance.

1. Introduction

Electroplating is a process of plating a metal film on the surface of metal devices by electrolytic principle. It can improve the wear resistance, electrical conductivity and aesthetics of metal surface by electroplating processing. The main components of electroplating coating are copper, nickel, gold, silver, tin and lead. According to the application fields and process requirements of electroplating devices, the requirements of electroplating components are different. For example, the corrosion resistance and wear resistance of metal devices can be improved by nickel plating, and the conductivity and signal transmission of metal devices can be improved by silver plating. Therefore, the choice of coating material plays a fundamental role in the quality standard of electroplating processing. In the process of quality monitoring of electroplated work piece, it is necessary to identify the coating of electroplated device effectively and accurately, so as to ensure the quality and process of electroplated work piece. It is of great significance to study the identification method of the composition of electroplated coating in the fields of electroplating process monitoring and processing.

Composition of electroplating coating can be classified into base, appearance, and functional components. It is of great significance to effectively and accurately identify the content of various components in improving electroplating performance and electroplating processing technology. Among the traditional identification methods, there are mainly ray recognition method, particle detection method, electrode detection method and magnetic detection method, etc. Literature[3] presents a method of coating composition identification based on THz spectral density functional. Solvent eutectic is used to generate the spectral characteristics of the coating to realize the recognition of the metal composition of the coating. This method is easy to produce characteristic peak offset in coating detection by terahertz time domain spectroscopy technology, and the effect of coating composition identification is not ideal. A single layer of MoS2 metal ionizing solution was prepared in electrolyte based on the identification method of coating composition for alloy negative electrode ionization detection, and the alloy composition was identified by chemical analysis method. However, the recognition performance of this method was poor in the case of many kinds of coatings and complex composition. The X-ray detection method carried out energy spectrum

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detection in the process of excitation state transition of radiation to realize the identification of coatings, but this method did not. The principle of this method is complex, and it cannot be accurately identified when the coating is seriously oxidized. In order to solve the above problems, a design method of coating composition recognition system based on spectral image analysis is proposed in this paper. The method has high accuracy, simple method and wide application.

2. Principle Analysis of Recognition of Coating Composition

In the electroplating layer, the metal composition of the coating is composed of atomic nuclei and electrons. Under natural conditions, the spectral characteristics reflected by the metal of the electroplating layer will be attenuated in the spectral characteristics of the image pixels under external stimulation. γ-ray is a kind of high-frequency electromagnetic radiation. When the ionization frequency is over 10^{18}Hz, the pixel characteristics of the coating surface image will be in the state of de-excitation or cascade de-excitation to the base in the binary image. This characteristic of the coating spectrum image can be used to determine the composition of the coating by γ external stimulation. Spectrometric determination. According to the above recognition principle of coating composition, the method of spectral image analysis and image processing algorithm are used to realize the recognition and detection of coating composition.

Before image processing, it is necessary to know the image characteristic tables of several typical electroplating materials in the coating, as shown in Table 1 below.

Table.1 Image Characteristic Table of Several Typical Electroplating Radioactive Substances

element	Pixel decay level	mixture	Number of photons	Average photon energy(MeV))	Half-life of spectral images(s)
U	1.23×10^{4}	1.34	2.81×10^{4}	0.51	4.51×10^{9}
Th	4.02×10^{3}	3.41	1.0×10^{4}	0.24	1.42×10^{10}
K	31.3	0.21	2.4	1.56	1.25×10^{9}
Ra	3.63×10^{10}	3.20	8.0×10^{10}	0.87	1654

3. Design of Coating Composition Recognition System Based on Spectrogram Analysis

3.1 General Logic and Functional Design of the System

On the basis of spectral image acquisition and storage, the design of coating composition detection system can be completed by spectral analysis: the system uses scintillation probe to detect the coating spectrum, converts the gamma ray of the coating into electric pulse signal, maintains the peak voltage through low-speed A/D, and carries out spectrum measurement of the coating. The output electric pulse signal first detects the pulse amplitude of the electrode posit by analyzer fluorescent screen, and more intuitively observes the composition of the cast film sample. Baseline restorer is added before A/D converter. Baseline restore automatically detects the composition of the deposit to the next buffer. The detected spectral image is processed by DSP digital signal processor, and the peak value of the last buffer data is detected. In order to increase the driving capacity, the isolator is used to sample the input image information at high speed, and the isolator is used to send the detected coating composition information to the transceiver [9]. According to the system design and overall description, the overall structure of the coating composition recognition system based on spectral image analysis is obtained, as shown in Fig. 1.

As can be seen from Fig. 1, the overall structure of the coating composition recognition system based on spectral image analysis designed in this paper has the functions of high voltage control and baseline recovery. By extracting the spectral image features of the coating, the composition information characteristics of the coating can be effectively reflected. The content of oxygen impurities on the surface of electrodeposited gold foil and the contents of Cu, Ag and K in the electrodeposited gold foil were measured by spectral image analysis.

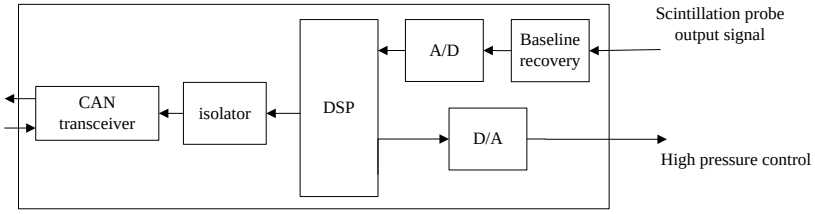

Fig. 1 Overall structure of coating composition identification system

3.2 A/D Module and Processor Module Design of Recognition System

On the basis of the overall design of the system, modular design of the system is needed, including the design of spectral image acquisition module, A/D module, D/A module, system power supply module and other peripheral circuits. The spectrum image acquisition module of electroplating adopts probe input. The probe is mainly used for image access, instruction access and input/output interface, input/output controller and other image information processing. Floating-point DSP and fixed-point DSP are used for full-duplex image sampling, and 8-bit A/D chip can effectively meet the needs of electroplating composition recognition. In the spectral image analysis of the composition of the electroplating layer, the lower the power consumption is, the larger the heat dissipation is. The working temperature of the system is - 40 C~85 C. In the image recognition system, the Blackfin image processing software recently promoted by ADI company is used to realize the image processing and signal acquisition of 32-bit RISC instruction set.

A/D module chooses ADI's high-speed A/D chip. In the spectrum analysis of the coating, the composition of the coating is separated and sampled by 16-bit current output D/A data. Among them, the input voltage of the plating layer is 280, and the interface mode is serial, which ensures the convenient connection with the DSP. When electroplating, the clock circuit is designed by using coated metal or other insoluble materials as anodes. In the process of electroplating composition identification, the recognition and classification of coating spectral characteristics are realized by clock circuit. Because ADSP-BF537 has an internal clock oscillator, the clock circuit designed in this paper uses the active crystal oscillator with voltage as the clock source, and obtains the clock circuit design diagram, as shown in Figure 2.

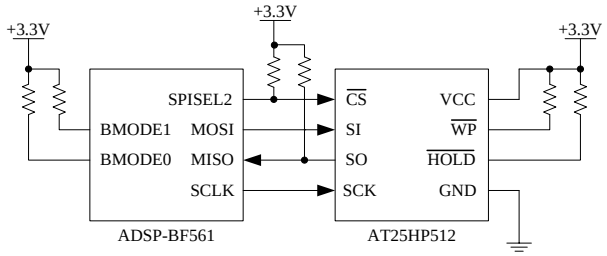

Fig. 2 Electroplating Composition Recognition Clock Circuit

Finally, the design of D/A module and power supply module of the system is carried out. In the image processing system of spectral image, the logic timing of the whole chip is controlled by input clock. The digital output includes 12-digit output and an overflow indicator bit. Using AD5545 and A D8674, a dual-channel identification signal with output range of 0-5 is generated. CLK connects the serial clock of DSP, AD. The output range of OUTA pin of 8674 is -2.5V-0V. Real-time energy spectrum data is uploaded through CAN bus. After adding a CAN transceiver, the DC power supply is used as the power supply for common mode suppression. In the design of chemical detection module, RF interference is reduced by controlling the slope. AN_H and CAN_L are connected with two capacitors in parallel with the ground, and 110 nodes are connected to construct digital isolators at low current. The peak value of A/D sampling buffer in electroplating was analyzed by energy spectrum measurement program. The first number of buffer was read and assigned to variable Input to realize the component identification of electroplating.

3.3 Algorithms Selection and Software Implementation of Spectral Image Processing for Coating

The acquisition and storage of coating spectral image is the precondition to realize the recognition of coating composition, and the analysis and processing of spectral image is the key of the whole system. Based on the traditional methods of coating laser imaging and infrared thermal image acquisition, a method of coating spectral image analysis based on laser infrared imaging is proposed. The method uses triangular mesh and TPS transform to reconstruct the coating spectral image. The flow chart is shown in Figure 3.

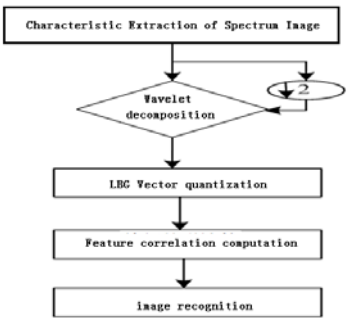

Fig. 3 The process of acquisition and recognition of spectral image features of electroplating layer.

4. Experimental results and analysis of simulation

In order to test the performance of the electroplating composition recognition system based on spectral image analysis, the system debugging and simulation experiments were carried out. In the experiment, the plating layer studied is an aluminum plating device. The plating layer is made of alloy and the main component is unknown. It needs to be detected by the spectral image analysis method and system designed in this paper. In the experiment, the low voltage and high current power supply is used to supply power to the plating bath. The plating bath contains metal-coated compounds. The composition, temperature, current density and time of the plating bath are respectively on. Pass Emulator settings under Windows.

The results of feature extraction from spectral images are shown in Figure 4. It can be seen that the results of feature extraction can accurately reflect the composition information of various alloy components of the coating when the spectral composition of the coating is analyzed by this method.

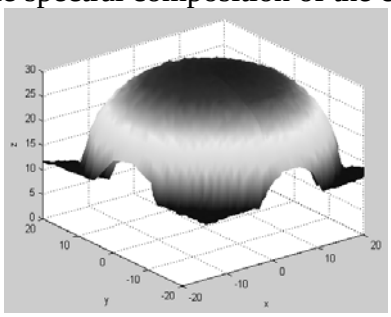

Fig. 4 The results of feature extraction of coating spectral image

The simulation results show that the coatings tested in this paper contain nickel, silicon, carbon, oxygen and other elements. The ratio is 25%, 10%, 15% and 5%, respectively. The test results are consistent with the actual situation, which proves the superiority of this method in the identification of coating composition.

5. Conclusion

In this paper, a method of coating composition recognition based on spectral image analysis is proposed. Firstly, the principle analysis and spectral feature extraction of coating are carried out. Then, the detection instrument of coating composition is designed by spectral image analysis

method. The spectrum image acquisition module adopts ADSP21160 processor system. Finally, the full duplex image sampling method of floating-point DSP and fixed-point DSP is used to realize image acquisition and location. Li. Software development and system implementation are carried out on Visual DSP+4.5 platform. The simulation results show that the method can accurately detect the composition and content of the coating.

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