

Development of MScCoating for Aircraft Engine Parts

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Many aircraft engine manufacturers apply coatings such as welding, thermal spraying and metal plating to parts that require abrasion resistance. However, problems include the fact that thermal spraying and metal plating need masking, and welding is likely to cause deformation or cracks of the workpiece due to heat concentration in the workpiece. In addition, these tasks must be done manually by skilled operators and are difficult to automate. To resolve these issues, we have developed MScCoating technology, which forms an accurate coating of layers in the desired shape wherever required. This article describes our MScCoating technology and its application to aircraft engines.

1. Overview of MScCoating Technology

With this technology, a metal or ceramic coating layer is formed on the surface of the workpiece by generating pulse electric discharges between the workpiece and an electrode. The electrode acts as the source of the coating material, which is transferred to the workpiece by the electric discharge. Figure 1 shows the process of forming the MScCoating layer. The electrode is formed from powder material and is easily broken up. When a voltage is applied across the electrode and the workpiece which are facing each other, electric discharge occurs. The energy of this electric discharge pulse melts the electrode material and breaks it up into tiny fragments. The fragmented electrode material is then transferred to the workpiece, where it re-solidifies on the workpiece surface. This process is repeated about ten thousand times per second to form a coating layer.

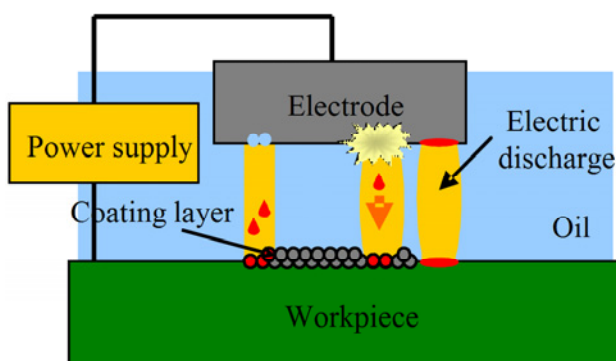


Fig. 1 Process of MScCoating

2. Features of MScCoating

The features of MScCoating are as follows:

- Strong bonding force between workpiece and coating layer, difficult to peel off
- Minimal heat-affected zone on workpiece, causing no cracks or distortion
- No masking required; coating layers of any shape can be formed anywhere
- Coating technology uses machinery, ensuring consistent quality of coating layer without relying on skilled technicians
- Adjustable electrode material and electric discharge pulse conditions, for forming various functional coating layers

3. Technologies Applicable to Aircraft Engines

An aircraft engine has many parts that require abrasion resistance under high-temperature conditions. This article reports an application of MScCoating technology to the interlocks of turbine blades. A turbine drives a compressor, whereby the energy of high-temperature and high-pressure gas generated in the combustor is converted into mechanical energy. As shown in Fig. 2, the turbine is structured such that adjacent blades are interlocked to form a circular shape. However, the blades are not bonded to each other and so grind against each other at the interlock and suffer wear while the engine is rotating. Conventionally, worn parts have been repaired by build-up welding, but this may cause excess thickness, and the heat may cause cracks or distortion of the workpiece.

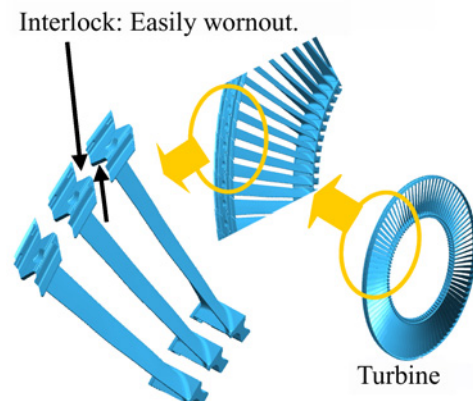


Fig. 2 Turbine blade

To resolve these issues, we have developed an MSCoating electrode composed of highly abrasion-resistant Co alloys. We conducted abrasion tests to evaluate the abrasion resistance of the coating layers formed under optimized conditions of electric discharge pulses. The tests were performed as shown in Fig. 3, where coating layers were formed either with build-up welding or MSCoating on the surface of a convex shaped workpiece of 5 mm in diameter and a cylindrical workpiece of 10 mm in diameter, which were then tested under the conditions listed in Table 1. When an aircraft engine is in operation, the temperature reaches nearly 1000°C, which necessitates evaluation over a wide temperature range from normal temperature to high temperature. The wear test result is shown in Fig. 4. In the case of build-up welding, severe wear was observed in the temperature range experienced while an aircraft is in cruise flight, i.e. from 350°C to 480°C, whereas the coating layer with MSCoating suffered almost no wear at any temperature, demonstrating high wear resistance. As indicated by these results, the newly developed MSCoating layers have high abrasion resistance and are expected to provide benefits including faster turbine blade repair and longer interval between inspections. In addition, the MSCoating does not cause cracks or distortion of the workpiece or generate excess thickness, and thus solves the issues of build-up welding such as excess thickness, and cracks and distortion of the workpiece.

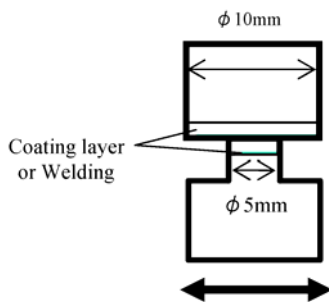


Fig. 3 Abrasion test model

Table 1 Abrasion test condition

Stroke length	0.5 mm
Test pressure	3 – 7 MPa
Frequency	40 Hz
Test temperature	<ul style="list-style-type: none"> • Room temperature • 300°C • 480°C • 870 °C • 930°C

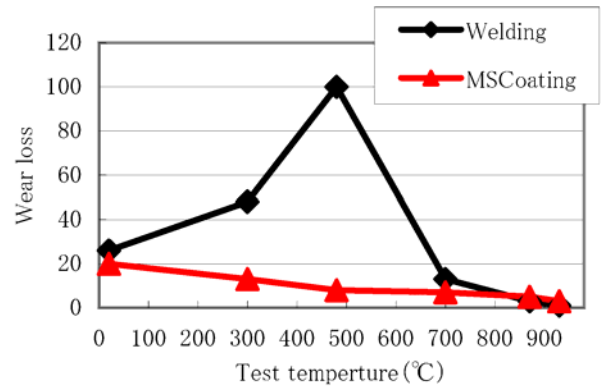


Fig. 4 Abrasion test result

4. Future Direction

In October 2007, the MSCoating was certified by the Federal Aviation Administration (FAA) and approved for application to aircraft engines. In 2008, the first flight of an aircraft treated with MSCoating is scheduled to be held. We will continue with development work to expand the range of applicable aircraft engine parts as well as create various functional coating layers for automobiles, medical use and machine tools. Finally we thank Mr. Ochiai of IHI and many other people for their cooperation in the development and application of this technology.

References:

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