

H11 MCrAlY's – Oxidation and corrosion resistant coatings

Gas turbine section components are made of nickel or cobalt based superalloys. These superalloys are well known for their high temperature strength, oxidation and corrosion resistance. Superalloys are widely used for high temperature environments in gas turbine engines. Unfortunately, alloy compositions required for high temperature strength run contrary to those for oxidation and corrosion protection. To obtain the best overall performance, high strength superalloys can be coated with a corrosion and oxidation resistant MCrAlY. MCrAlY's are a family of superalloys which have a base metal (M) of cobalt, nickel or iron, combined with chromium, aluminum and yttrium (Figure 1).

Element	Weight %
Nickel	Balance
Cobalt	22
Chromium	17
Aluminum	12.5
Yttrium	0.6

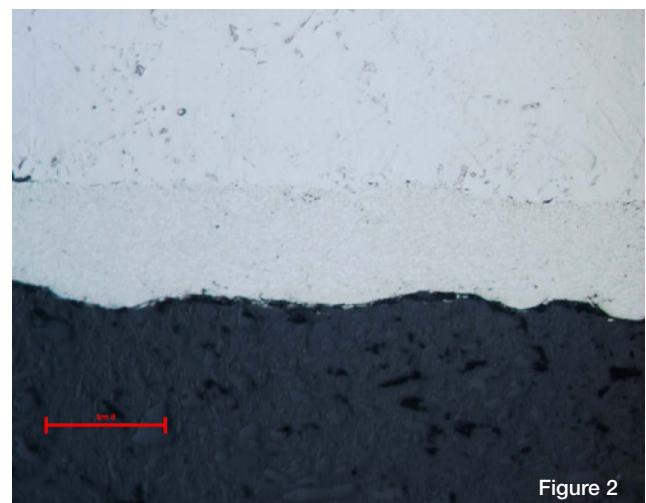
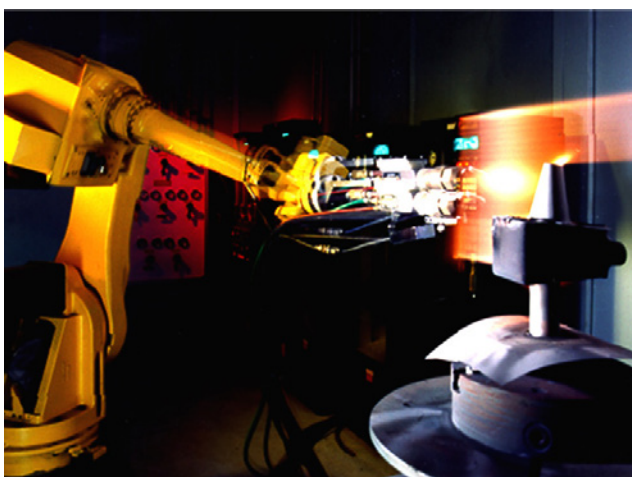


Figure 2



MCrAlY coatings may be utilized on both stationary and rotating components in the hot section of gas turbine engines. Examples of parts which benefit from MCrAlY coatings include turbine blades, vane segments and shroud blocks. MCrAlY coatings can also be used as protective bond coats for yttria stabilized zirconia thermal barrier coatings. Figure 2 shows a 200X cross sectional photomicrograph of H11. Coating thickness typically measures 5-10 mils, but can be applied up to 25 mils.

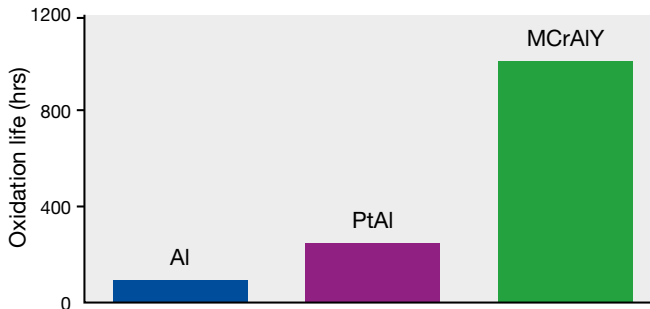


Figure 3. Oxidation life of selected coatings at 2'075°F

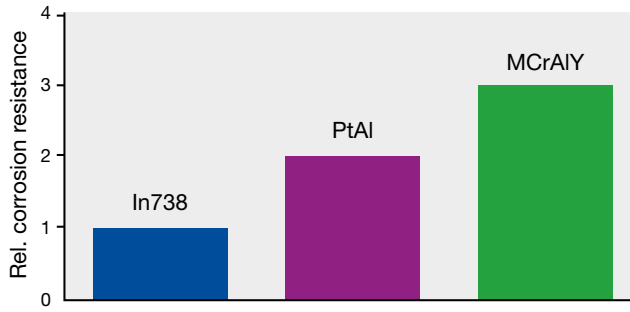
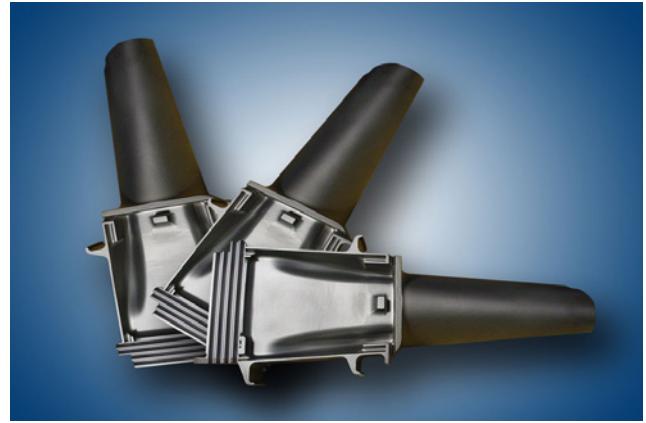


Figure 4. Corrosion resistance of PtAl and MCrAlY coatings



MCrAlY coatings have a history of superior performance when compared to PtAl coatings. The high temperature oxidation resistance of MCrAlY coatings is compared to Al and PtAl in Figure 3(1). As shown in the chart, the oxidation resistance of the MCrAlY coating is much greater than that of the aluminide or PtAl coatings.

Sulzer Turbo Services Houston offers H11, an NiCoCrAlY designed primarily for high temperature oxidation resistance. H11 also offers protection from high temperature corrosion and is applied using a High Velocity Oxy-Fueled (HVOF) gun. HVOF produces low oxide coatings with high bond strength and smooth surface profile by means of state-of-the-art automated equipment and robotics to ensure the highest quality product.

Turbine blades and the MCrAlY advantage

Turbine blades manufactured from high strength superalloys typically do not possess adequate high temperature corrosion and oxidation resistance. This problem can be solved by applying a protective coating over the entire airfoil.

The types of coatings normally used for this application include aluminides, platinum aluminides (PtAl), and MCrAlY coatings. MCrAlY coatings can be applied by vacuum plasma (VPS), low pressure plasma (LPPS), or high velocity oxy-fueled (HVOF) spraying. The composition of MCrAlY coatings can be tailored to meet the demands of different environments.

The oxidation resistance of a coating is dependant on the formation of stable aluminum oxide on the surface. MCrAlY coatings readily form this oxide. In addition, the yttrium in the MCrAlY coating can migrate to the surface and anchor the aluminum oxide scale, increasing its stability.

The corrosion resistance of MCrAlY coatings is also greater than that of PtAl coatings (figure 4)(2). In the hot section of a gas turbine, engine salt deposits can attack the aluminum oxide layer, migrate through the coating and corrode the base material. However, The high concentrations of chrome in an MCrAlY coating combat the corrosion. The chrome forms an oxide on the surface of the coating that is not readily attacked by the salts.

The thickness of a typical MCrAlY coating (.006-.010 inches) is up to four times greater than that of an Al or PtAl coating. Due to increased coating thicknesses, there are larger amounts of critical elements (aluminum and chrome) available to form protective oxide layers. Also, unlike diffusion coatings, MCrAlY's are not dependent on substrate chemistry.



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1. Sims, C. et al.; Superalloys II; John Wiley & Sons; New York (1987).
2. Schilke, P.W. et al.; "Advanced materials Propel Progress in Land Based Gas Turbines"; Advanced materials & Processes; March 1992