

# Corrosion Resistance of a Cast-Iron Material Coated With a Ceramic Layer Using Thermal Spray Method

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**Abstract.** Cast-iron 250 used for breake systems present many corrosion signs after a mean usage time based on the environment conditions they work. In order to improve them corrosion resistance we propose to cover the active part of the material using a ceramic material. The deposition process is an industrial deposition system based on thermal spraying that can cover high surfaces in low time. In this articol we analyze the influence of a ceramic layer (40-50  $\mu\text{m}$ ) on the corrosion resistance of FC250 cast iron. The results were analyzed using scanning electron microscopy (SEM), X-ray energy dispersive (EDS) and linear and cyclic potentiometry.

## 1. Introduction

Automotive industry represents a higher metallic materials consumer. Millions of cars still present a high usage of metallic materials. The necessity of quality materials is observed in all the metallic materials applications [1, 2]. Safety represents an important issue of cars manufacturers. The brake system is designed to slow down and halt the motion of the vehicle. Various components are used in braking system to convert the momentum (kinetic energy) in to heat energy using friction. Two forms of friction play important role in automotive braking:

- kinetic friction,
- static friction.

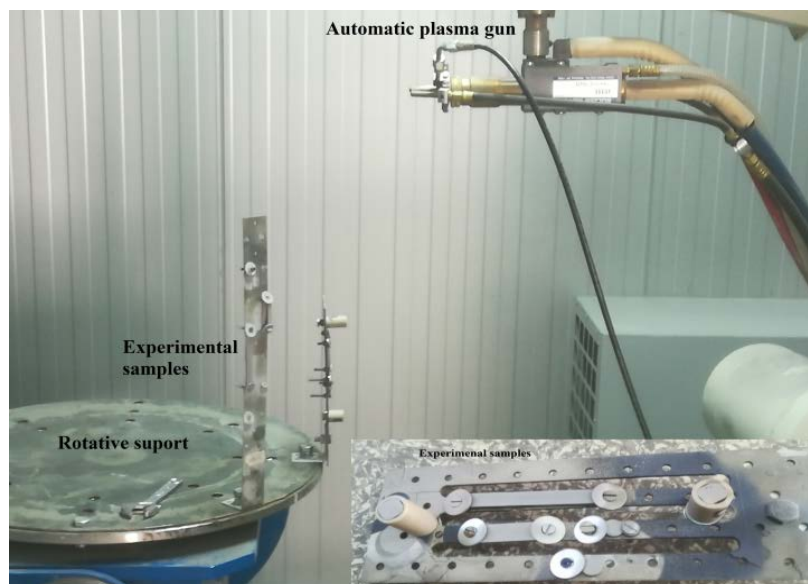
Braking action creates kinetic friction kinetic friction in the brakes and static friction between the tire and road to slow the vehicle. When brakes are applied, the vehicle’s weight is weight is transferred to the front wheels and is unloaded on the rear unloaded on the rear wheels [3, 4]. There are four basic factors determine the braking power of the system. Pressure: through pressure – amount of friction generated between moving surfaces contacting one another depends in part on the pressure exerted on the surfaces. The hydraulic force is used to move brake pads or brake shoes brake shoes against spinning spinning rotors or drums mounted on the wheels. Coefficient of friction in automotive brakes, the COF expresses the frictional relationships between pads and rotors or shoes and drums and is carefully engineered to ensure maximum performance (COF 0.25 to 0.55) [5]. Frictional contact surface it is the amount of surface or area frictional contact surface – it is the amount of surface, or area, that is in contact. Bigger brakes stop the car more quickly [6]. Heat dissipation is a large amount of heat is produced in brakes. The weight and the speed of the vehicle determine the braking mechanism [7, 8].



In this article we analyze the corrosion resistance of FC250 cast iron material with and without a ceramic layer  $\text{Al}_2\text{O}_3$ . The ceramic layer was deposited using a plasma deposition automatic arm from 2-5  $\mu\text{m}$   $\text{Al}_2\text{O}_3$  powders.

## 2. Materials and methods

A usual cast iron material (FC250) used for automotive braking system was covered with a ceramic material (105NS-1 aluminum oxide) using an industrial deposition system (Sulzer Metco). The reason was mainly to improve the corrosion resistance properties. Plasma jet was covered by Ar (pressure 5.2 bar and gas flow 39 NLPM) and H (pressure 3.4 bar and gas flow 6.6 NLPM). We apply 4 passes (around 12-15  $\mu\text{m}$  by layer) [8, 9]. Samples for corrosion resistance analyze were prepared by mechanical grinding, sand blasting and mechanical fixation for deposition [8-10]. The experimental set up is presented in Figure 1 and is form by a rotational support, automatic arm for pulverization and samples holder. The experimental equipment presents a high covering area with a good potential of applications in the industrial field.



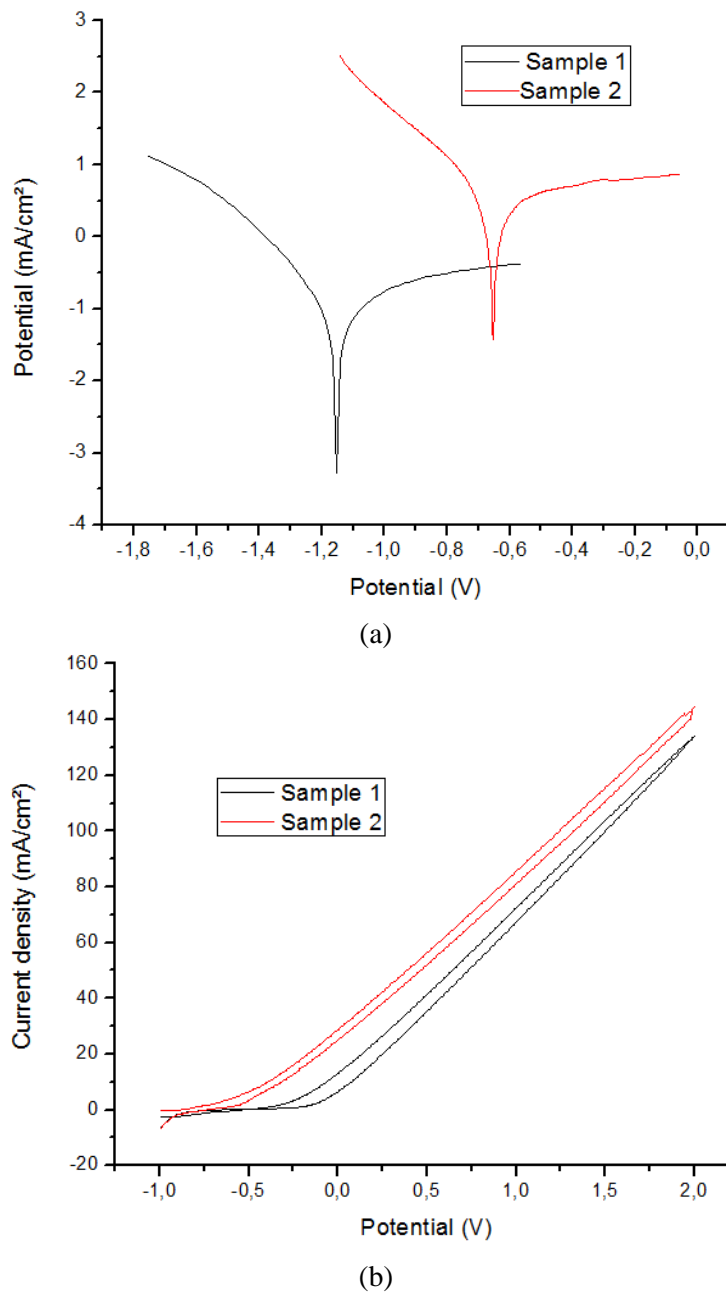
**Figure 1.** Experimental set up for deposition of  $\text{Al}_2\text{O}_3$  ceramic layer.

After the samples preparation and deposition the materials were cooled down to room temperature. The material surface after deposition of ceramic material  $\text{Al}_2\text{O}_3$  via plasma jet and after electro-chemical corrosion test was analyzed using VegaTescan LMH II scanning electron microscope and Bruker detector for X-ray energy spectroscopy. The electro-chemical corrosion resistance test was realized using potentiostat equipment with three electrodes, one being the experimental sample.

## 3. Results and discussions

In Figure 2 we present the electro-chemical corrosion test results a) Tafel linear potentiometry and b) cyclic potentiometry curves. A considerable improve of corrosion resistance is observed for the metallic sample, 0.8 V potential, covered with the ceramic layer that have a protective role.

Both materials present a generalized corrosion type, Figure 2 b), with a smaller slope for the metallic material covered with the ceramic layer. The corrosion resistance behaviour present an improve for the metallic material with a ceramic layer but further investigations on the interface between the metallic and the ceramic layer are necessary. The experiments were realized in rain water meet on the streets of city Iasi. In Table 1 the experimental electro-corrosion resistance tests parameters are presented.

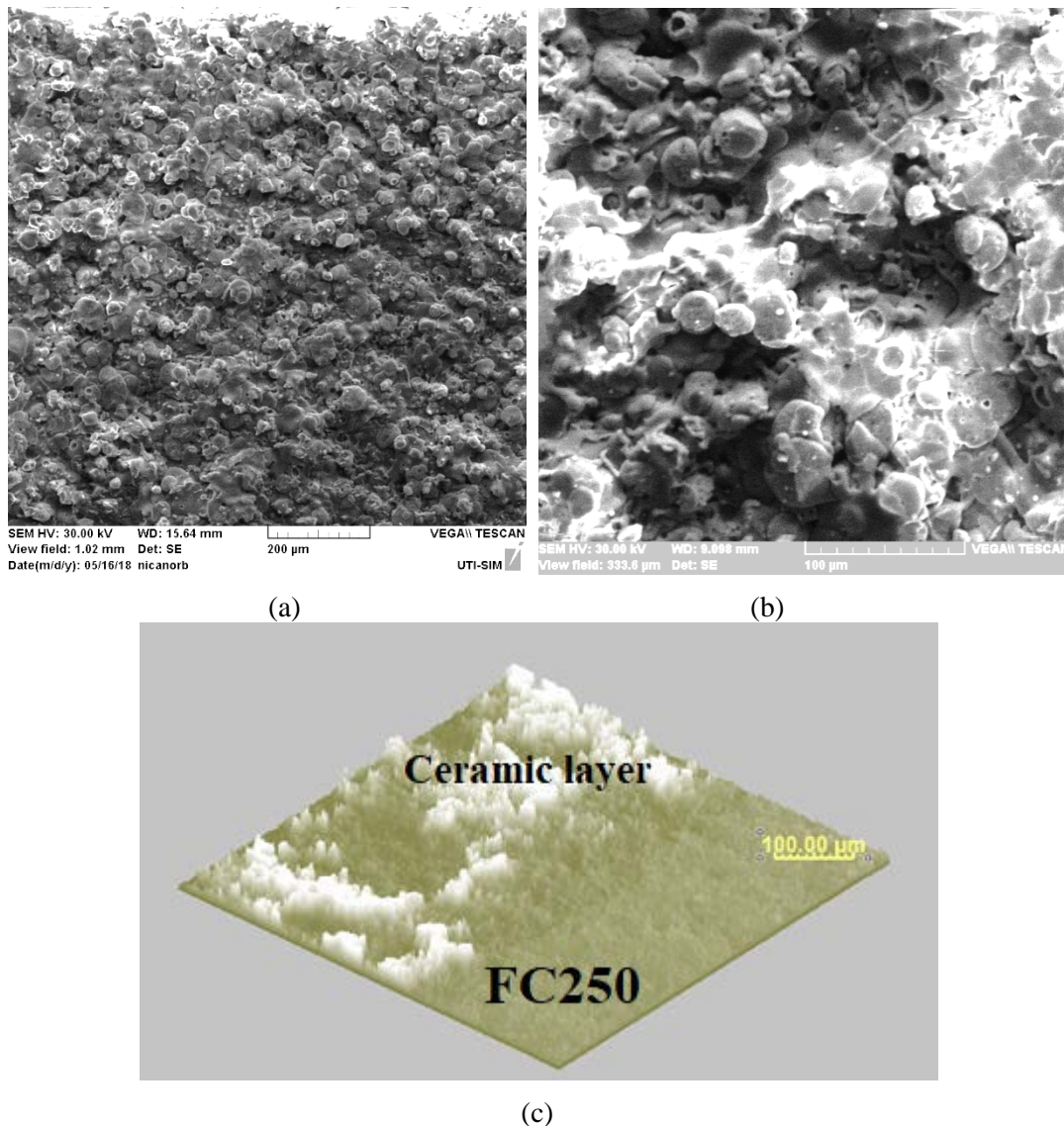


**Figure 2.** Electro-chemical corrosion test results (a) Tafel linear potentiometry and (b) cyclic potentiometry.

**Table 1.** Experimental electro-corrosion resistance test parameters.

Sample	$E_0$ mV	$b_a$ mV	$b_c$ mV	$R_p$ ohm.cm <sup>2</sup>	$J_{cor}$ mA/cm <sup>2</sup>	$V_{cor}$ mm/year
Sample 1	1150.2	730	765	694.57	2.16	1.61
Sample 2	654.1	350	389	23.84	1.87	0.38

The ceramic layer has a compact structure without micro-pores or micro-cracks. After the electro-corrosion test no compounds were observed on the surface also no pitting holes were observed in the ceramic layer.



**Figure 3.** SEM micrographs (a) ceramic layer, (b) ceramic layer after electro-corrosion test and (c) 3D image of ceramic layer at the interface with the metallic material.

The difference between covered and un-covered samples is more than 1.2 mm/year corrosion rate. The corrosion resistance is obviously improved using the ceramic layer (Figure 3 c). Chemical composition of the surface was not affected by the electro-chemical tests so no oxides or other compounds were observed on the surface [11-18]. Ceramic layers present a very good behaviour at electro-corrosion tests.

#### 4. Conclusions

Corrosion resistance of a metallic material, usual use as breaking discs, FC250 cast iron was improved through a plasma jet deposition of a ceramic layer. In order to improve the ceramic layer adhesion to the metallic material a sandblasting process was applied to all elements. A thick  $\text{Al}_2\text{O}_3$  layer was obtained after four passes with plasma jet. The corrosion resistance was highly improved after the ceramic layer deposition. No oxides or other compounds were observed on the ceramic surface after de electro-corrosion test. The electro-corrosion tests were performed in city rain water. The electrolyte solution contains dust and contaminants from the city environment.

## 5. References

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