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# Plasma electrolytic processing for polishing of stainless steel surfaces

**Thanh Dang Van*, Sung W.Kim, Jong R.Kim, Sang G.Kim**

Plasma Enhanced Technology Development Team, Production Technology Center, KITECH

- E mail: ***thanhdv@ims.vast.ac.vn***

**Abstract**

This paper presents the ability of plasma electrolytic polishing technology to polish surface of stainless steel materials. The results show that the surface of its can be polished clearly using potentiostatic regimes in various concentration of $(NH_4)_2SO_4$ solution that had been warmed to a certain initial temperature. The equipment and deposition produces for polishing process are described and the effect of processing parameters on the characterizations polished-samples has been has been investigated.

## 1. Introduction

The PEP is based on plasma electrolysis process that is performed at high potentials using solutions of mineral salts. Under these conditions, the electrolyte evaporates around the anode, which is a component to be treated, and forms the vapor-gaseous envelope (VGE) that have three types of boiling [2]: film, bubble and transient. The film type of boiling appears at low electrolyte temperature and leads to the heating of the anode up to 1000$^o$C. This high temperature could change bulk properties of the material; therefore, this type of boiling is not applied for the coatings removal and is not included in the chart. The bubble type of boiling in the VGE appears at the electrolyte temperatures close to the boiling temperature. This type of boiling is characterized by intensive hydrodynamic impact on the surface. This impact mainly results in the surface polishing. Compared with the conventional polishing method, the plasma electrolytic polishing is faster, ecologically cleaner, and cheaper. Therefore, in this report, we investigated the ability of PEP technology to polish stainless steel surfaces.

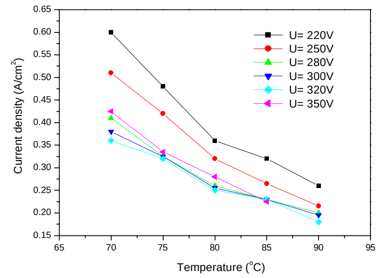
## 2. Experimental details

The stainless steel substrates with the reaction dimension of 10 mm x 50 mm x 1.5mm were sequentially ground and polished to achieve roughness of $R_a$ = 0.3 µm. They were treated using potentiostatic regimes in various concentration of $(NH_4)_2SO_4$ solution that had been warmed to a certain initial temperature, $T_{initial}$ = 70$^o$C. The workpiece was connected as the anode to the voltage supply unit. Electrolytic bath was made from stainless steel and acts as cathode in electrochemical system of polishing process. The schematic of these equipment is shown in Fig 1. Two types of voltage regime were employed as follows: DC and a pulse unipolar voltage, with frequencies varied in the from 5 kHz to 20 kHz range, step 5 kHz, Duty time(-)/Duty time(+): 45/50(%). The treatment time for the samples is 4 minutes. Actual power supply during the process was measured using a wattmeter built on the power supply. Other specifications can be found in references [3]. After PEP treatment, the samples were rinsed thoroughly in water and dried in hot air.

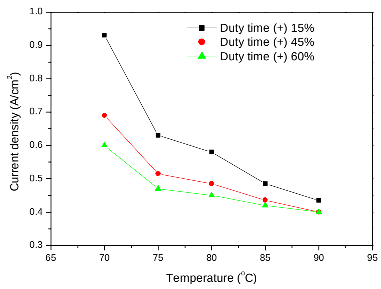
## 3. Results and discussion

### 3.1 Influence of temperature on density current

Fig 2 shows the dependence of density current on temperature and voltage. It can be seen that the current density is maximal at the moment of immersion of sample (or at the initial temperature) and gradually falls with increasing temperature.




(a)




(b)

Figure2. The dependence of current density on temperature at various DC voltage mode (a) and various duty time, pulse unipolar voltage, U=300V (b) , 3.5% $(NH4)_2SO_4$, 4 minutes.

It can be explained that at lower temperatures it is necessary to spend more than energy for creation and maintenance of a stable vapor-gas envelope (VGE). With increase in temperature, the liquid surrounding the surface the samples gets warmer, and the heat conveys into the rest of electrolyte, result in the VGE thickens, its electrical resistance goes up, which makes the current fall.

## 4. Conclusions

1. The results showed that plasma electrolytic polishing technology can effectively use for polishing or cleaning surface of stainless steel materials. The removal of surface takes places in the bubble types of boiling areas of the vapour-gaseous envelope.
2. The optimum conditions for PEP using DC voltage mode are: 3.5% $(NH4)_2SO_4$ solution at U= 300V, the initial temperature 70$^o$C.
3. The optimum conditions for PEP using pulse unipolar voltage mode are: 10kHz, $D^+/D^-$: 50/45 (%), U=300V, the initial temperature 70$^o$C, 3.5% $(NH4)_2SO_4$ solution.

## References

1. A.L. Yerokhin, X. Nie, A. Leyland, A. Matthews , S.J. DoweySurface and Coatings Technology 122 (1999) 73–93
2. D.I. Slovetsky, S.D. Terentyev, V.G. Plehanov, Teplofiz. Vys. Temp. 24 (2) (1986) 353 (in Russian).
3. S.I.Bahayeu, Sung W.Kim, 2008 Spring Conference of heat treatment May 10