

Field Electron Emission from W – Tips Coated with various Thicknesses of Polystyrene – Characteristics & Analysis

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Abstract:

This paper studies and analyzes the characteristics of cold field electron emission from clean Tungsten tips coated with an insulating layer^[1-3] of polystyrene^[4] using various thicknesses. The process testing the samples has been done under high vacuum conditions (10^{-8} mbar). Clean W – tips were prepared using electrochemical etching process. The current – voltage characteristics of the samples before and after being coated were studied, analyzed using the Fowler – Nordheim^[5] and Murphy – Good plots^[6] and were tested using the field emission orthodoxy test^[7,8]. Scanning electron micrographs for the samples under investigation have been imaged. Additionally, the electron emission patterns, before and after the coating process, are included here, in order to compare the results being obtained which enables us to study the effect of the coating. The results obtained should improve performance that will be presented and analyzed.

Keywords Polystyrene risen, Tungsten tip, Field emission, Field electron emission, Murphy-Good plot, Fowler-Nordheim plot, Millikan-Lauritsen plot.

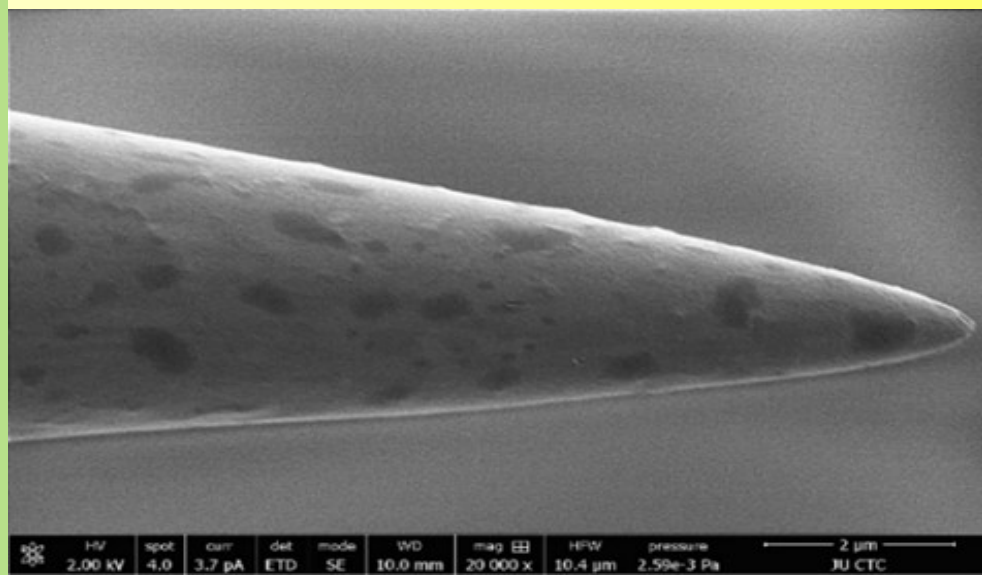
Methodology:

1. Preparation of insulating Polystyrene resins.

The solution was prepared in different concentrations. For the purpose of this study, the solution was prepared using: 4g of Polystyrene dissolved with 50 ml of Toluene.

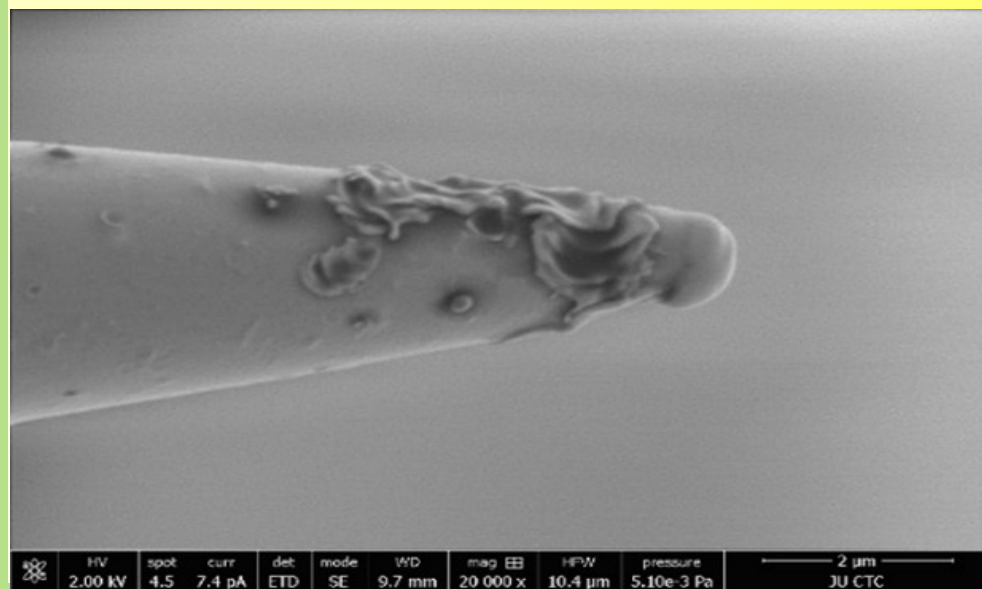
2. Clean W Samples

Base W Samples are prepared using the Electrochemical Etching Process.



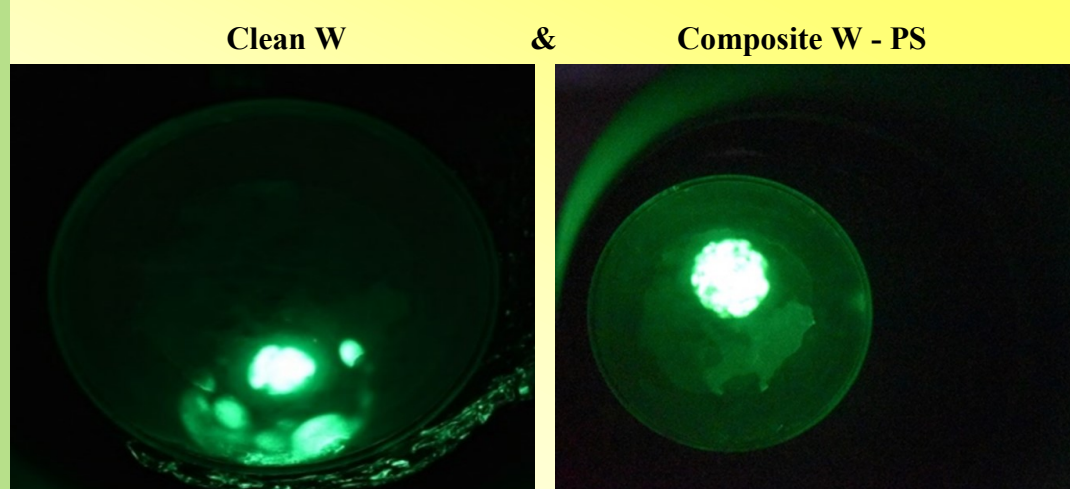
3. Composite W-PS Samples

The coating procedure involves very slowly dipping for the clean W tip into the PS and then accurately removing it to ensure that only a thin film remained on the tip surface to obtain regular layer of the PS film.



Experimental Results:

1. FEM pattern Images from:



Conclusions:

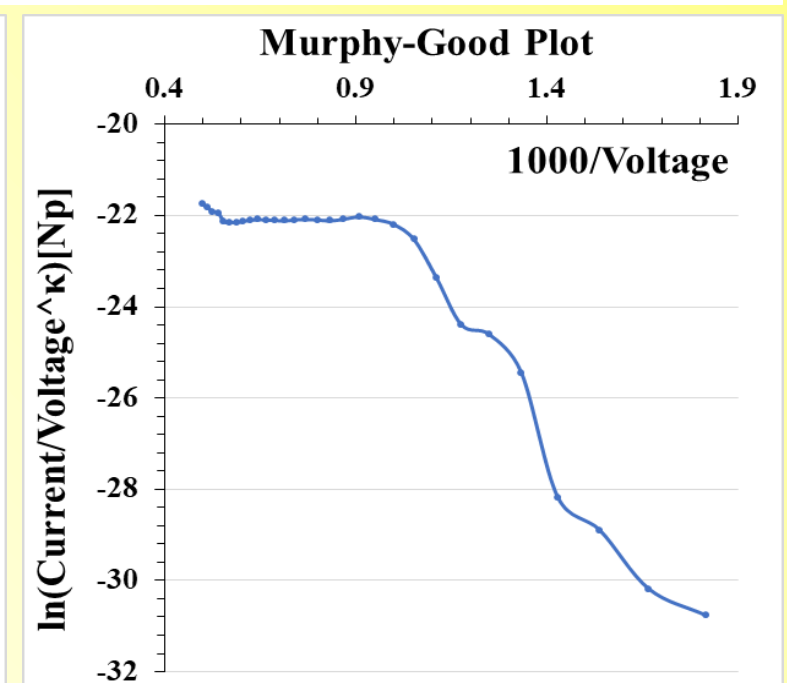
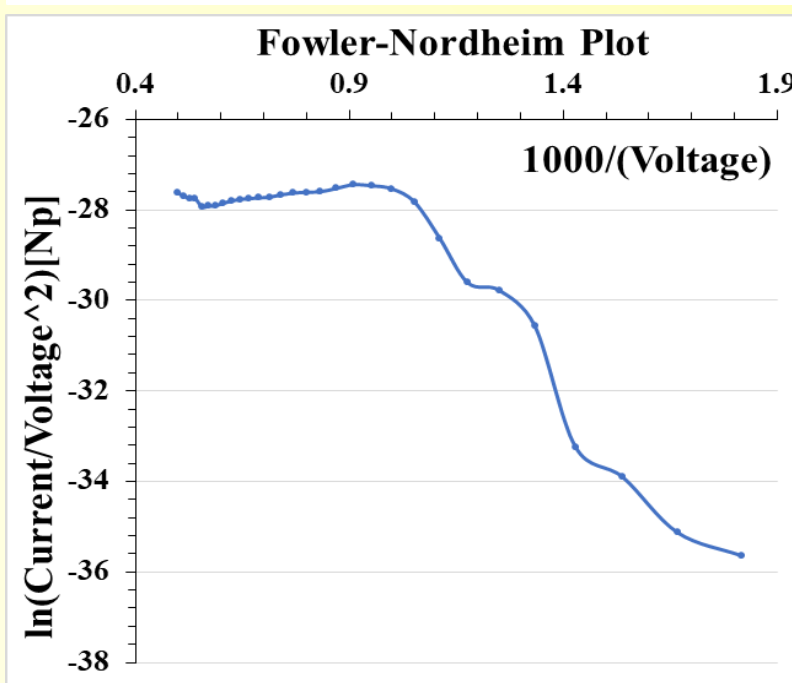
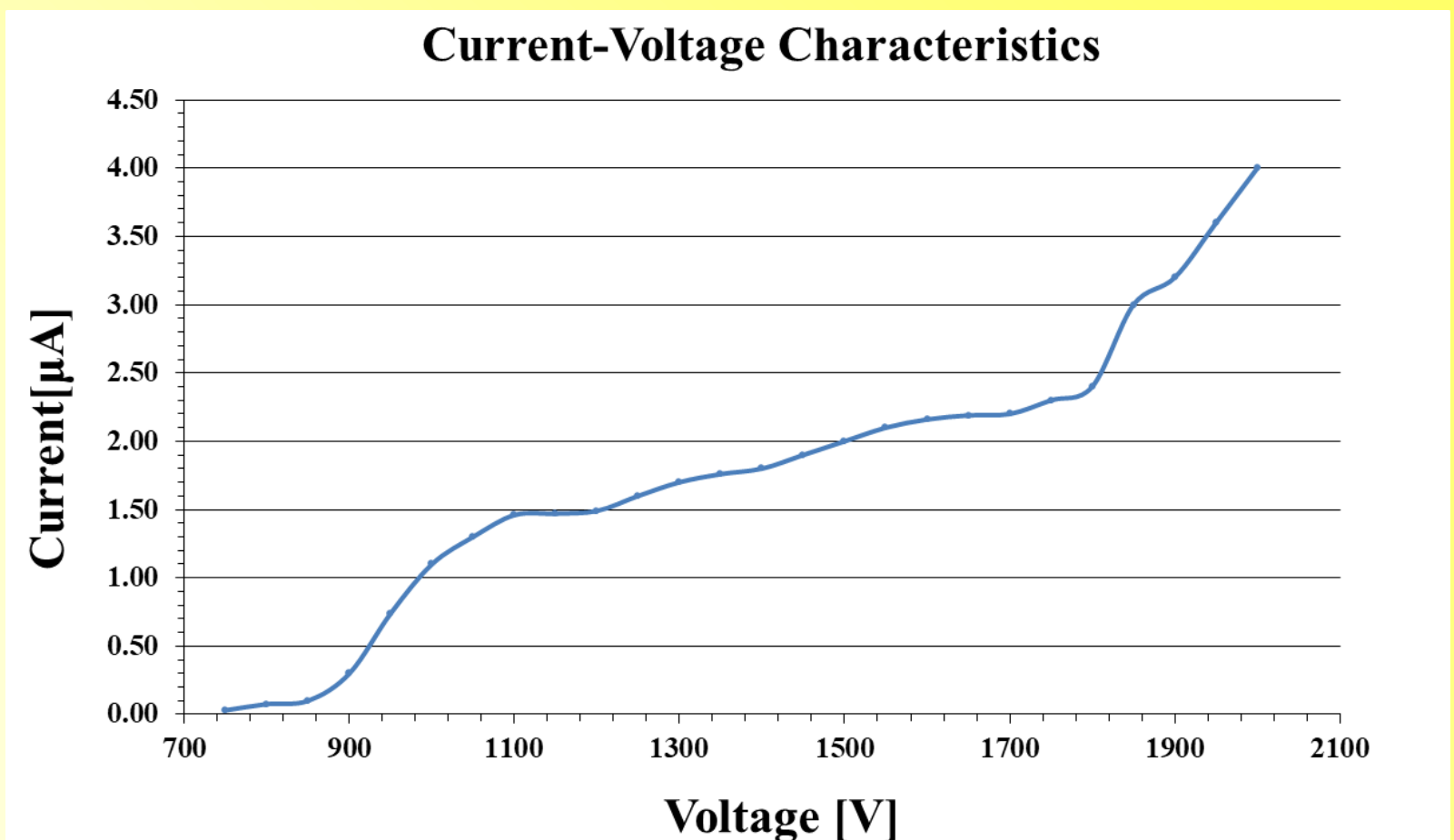
- By comparing the results obtained from the (I – V) characteristics for the clean and composite samples, it is clear that a composite emitter has more efficiency than a clean one.

- We note that coating the W field electron emitters with Polystyrene was a successful process since it improved the current values and reduced the required supply voltage that is required to start the emission process.

References:

1. R. V. Latham, M. S. Mousa, J. Phys. D: Appl. Phys., 19, 699 (1986).
2. M. S. Mousa, Surf. Sci. 94/95, 129 (1996).
3. M. S. Mousa., Surf. Interface Anal., 39, 102 (2007).
4. S. Parveen, A. Kumar, S. Husain and M. Husain, Phys. B Cond. Mat. 505 (2017).
5. R. G. Forbes, J. H. B. Deane, A. Fischer and M. S. Mousa, Jo. J. Phys. 8, 125 (2015). (2012)
6. R.G. Forbes, Proc. R. Soc. Open Sci. 6, 190912 (2019)
7. R. G. Forbes, Proc. R. Soc. Open Sci. 469, 20133027 (2013)
8. M.M. Allaham, R.G. Forbes, A. Knápek, M.S.Mousa, J. Electr. Eng. Slovak, 73 (1), 37 (2020)

2. Current-Voltage Characteristics, FN plot and MG plot for Clean W



3. Current-Voltage Characteristics, FN plot and MG plot for Composite W - PS

