University of BRISTOL

School of Chemistry

Growth of Diamond-Coated Nanostructures for Electrochemical and Bactericidal Applications: Appendix

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Second Assessor: Professor David Fermin

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Scanning Electron Microscopy

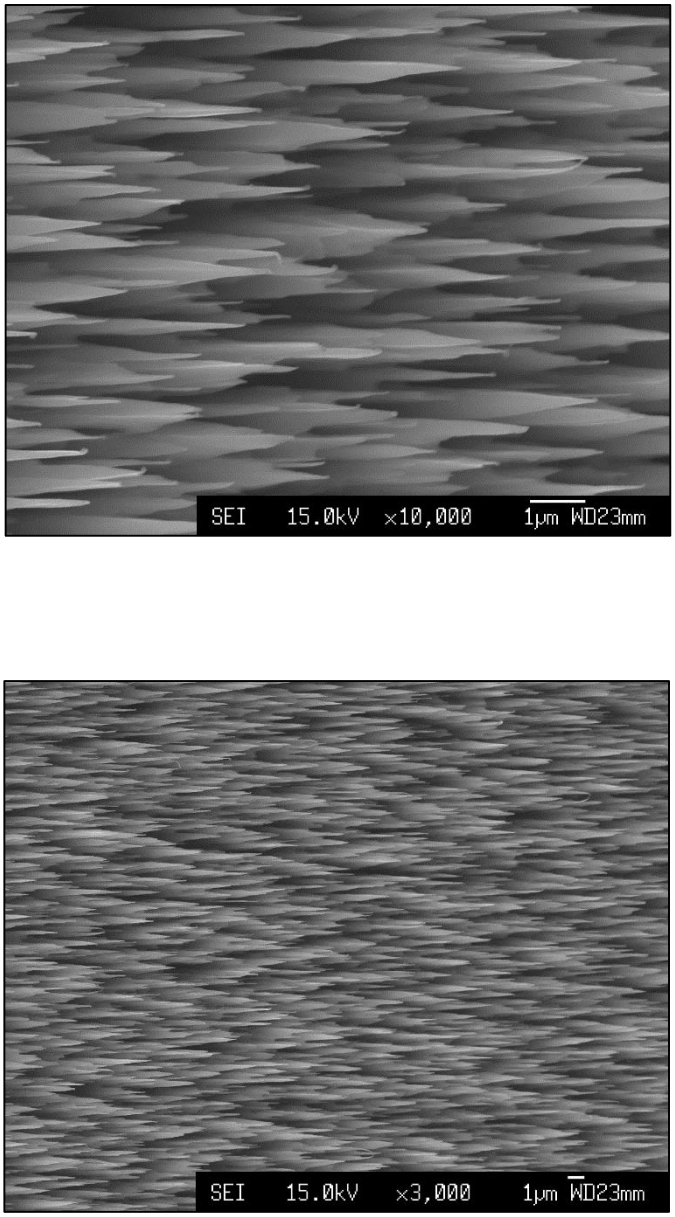


Figure 1: Scanning electron microscopy (SEM) images for uncoated large black silicon needles.

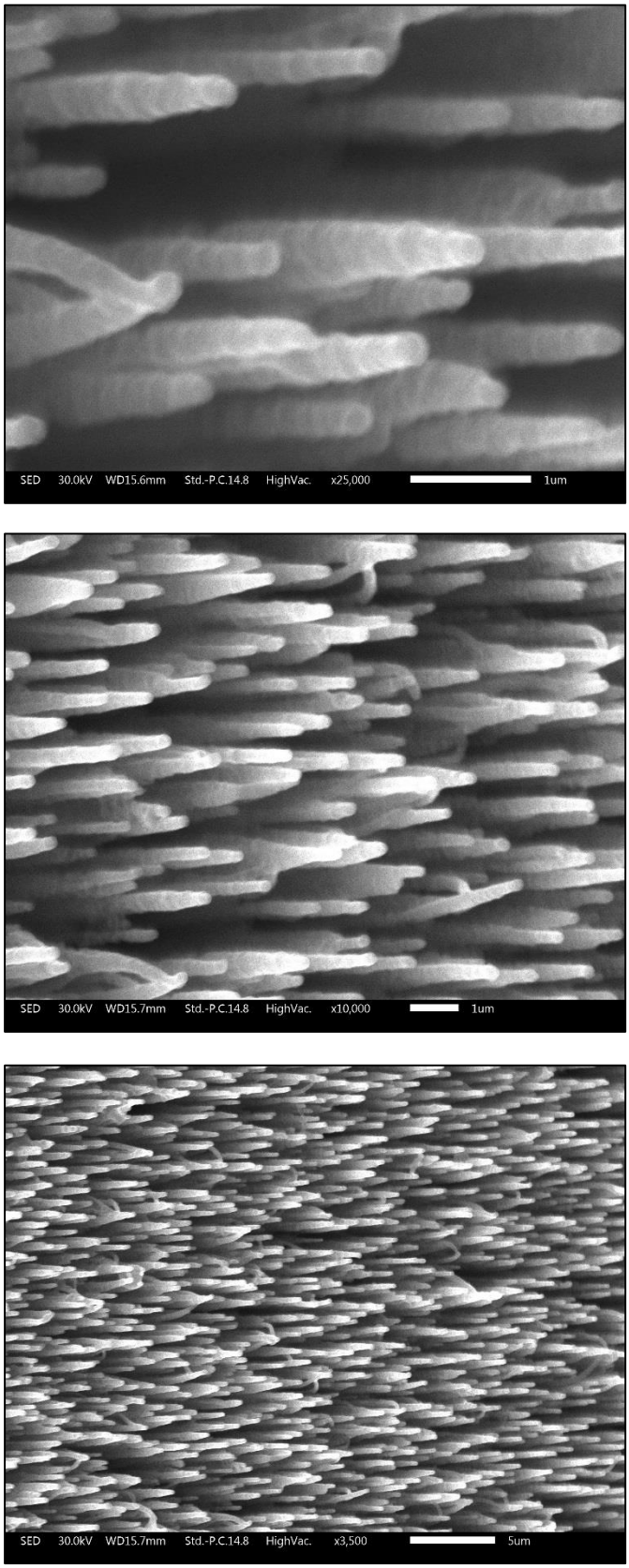


Figure 2: SEM images for large black silicon needles coated in a microcrystalline diamond (MCD) film grown for 20 mins after electrospray pretreatment.

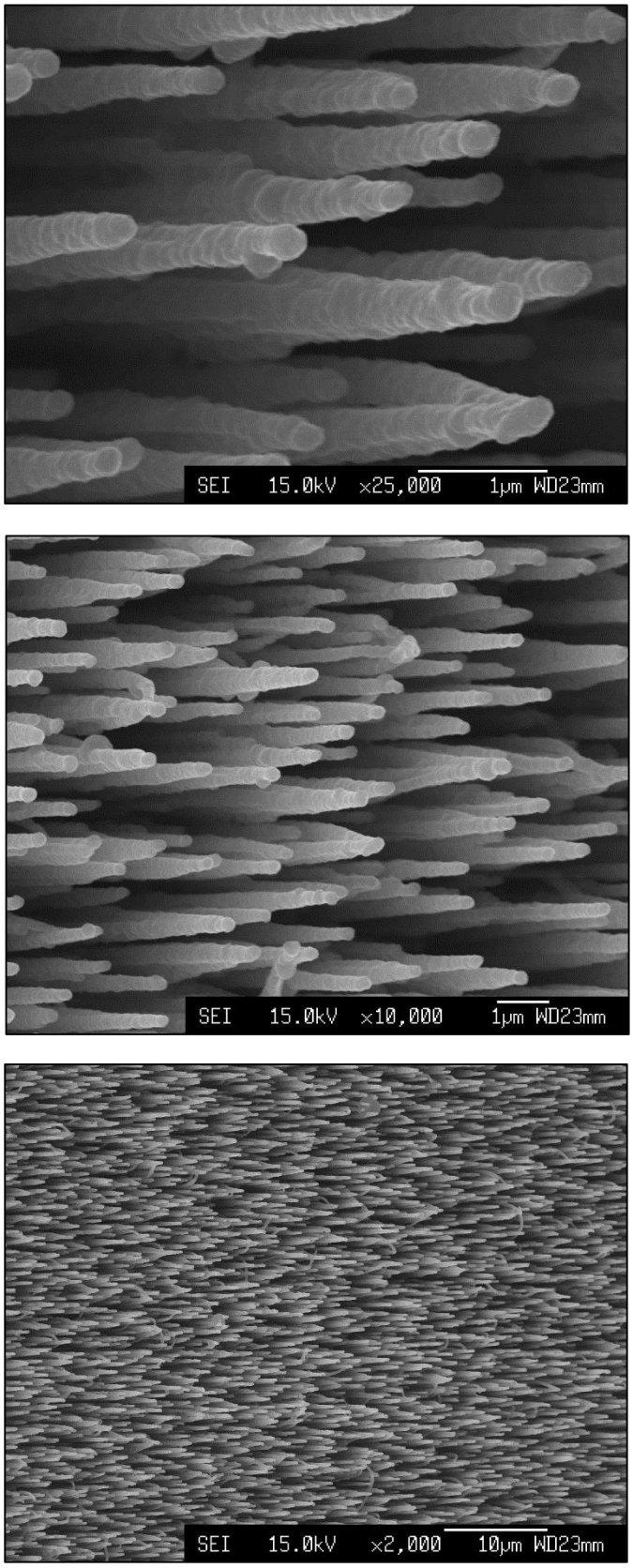
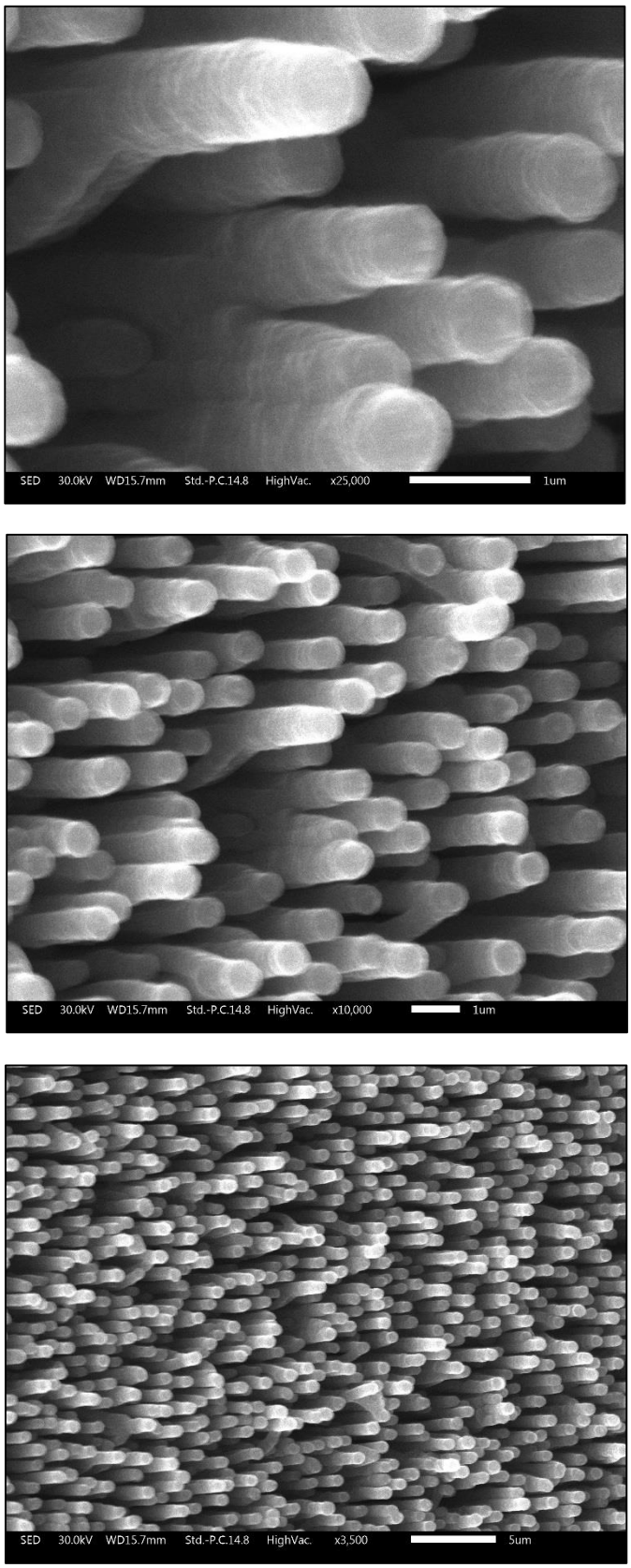


Figure 3: SEM images for large black silicon needles coated in a MCD film grown for 30 mins after electrospray pretreatment.



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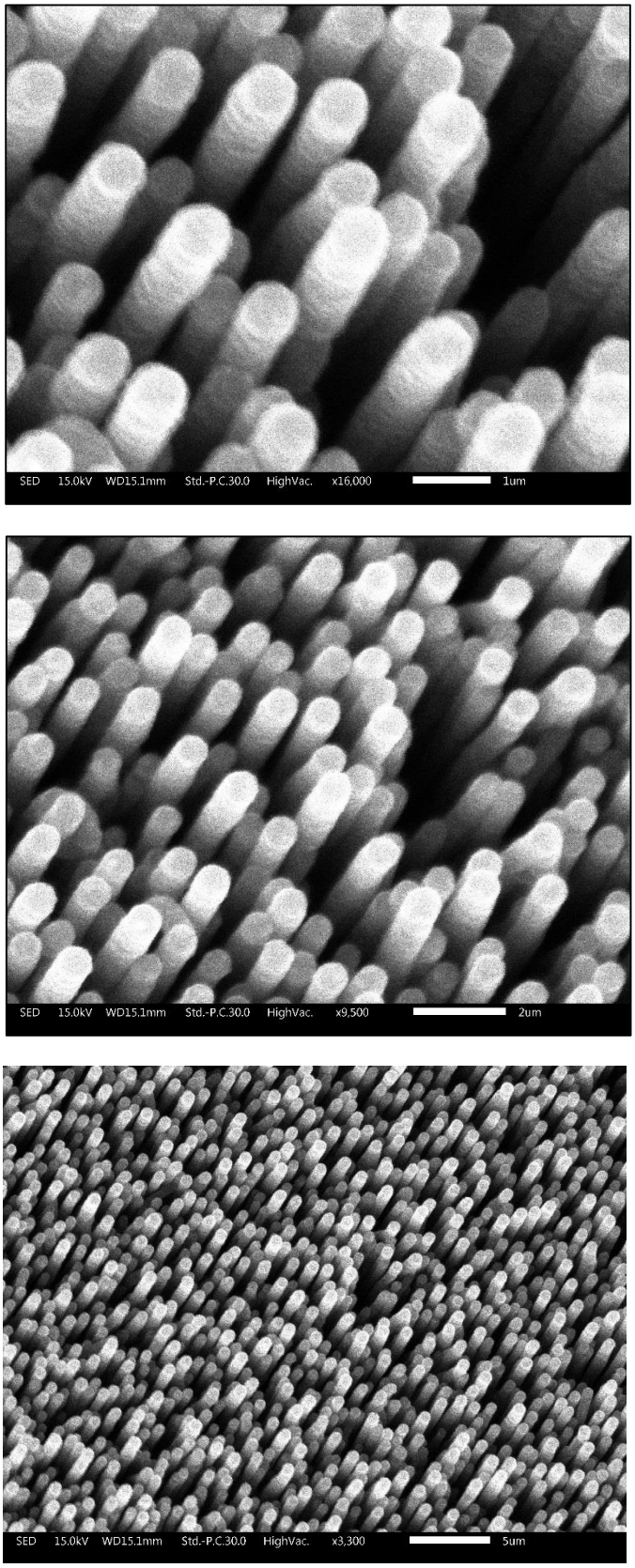

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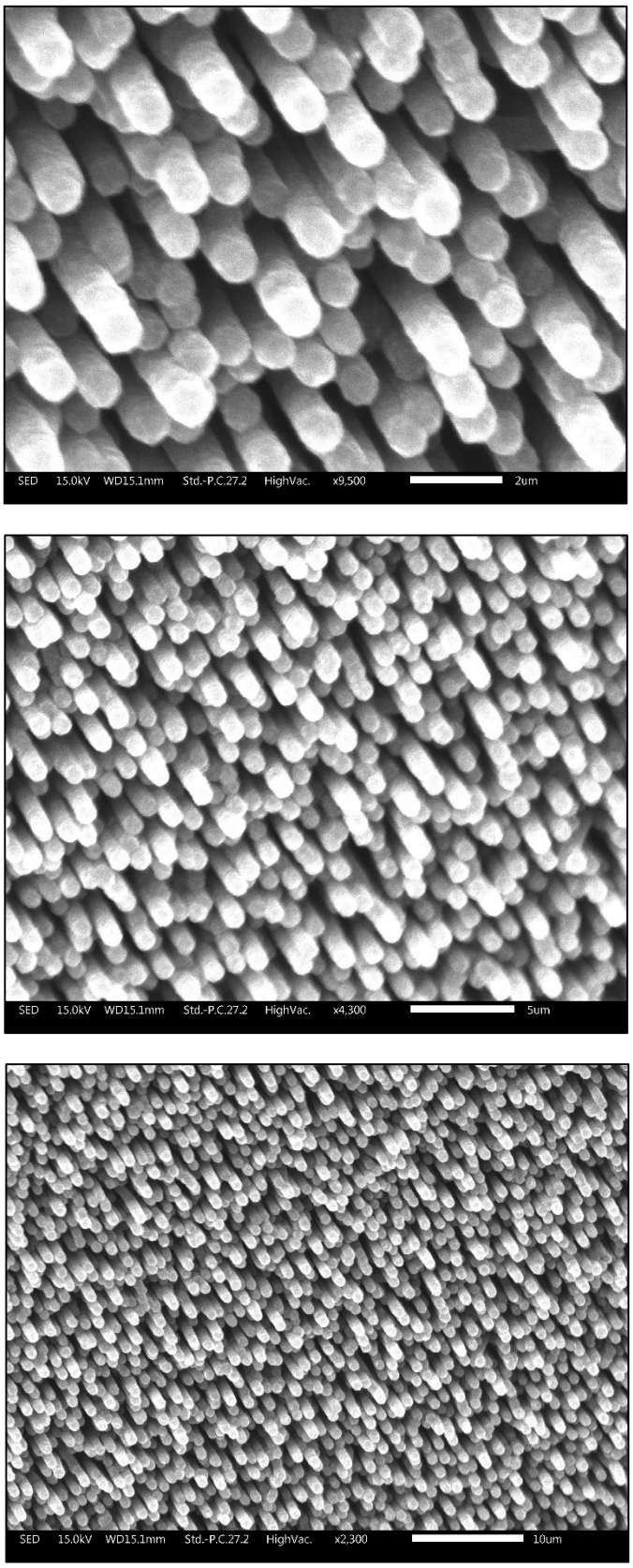
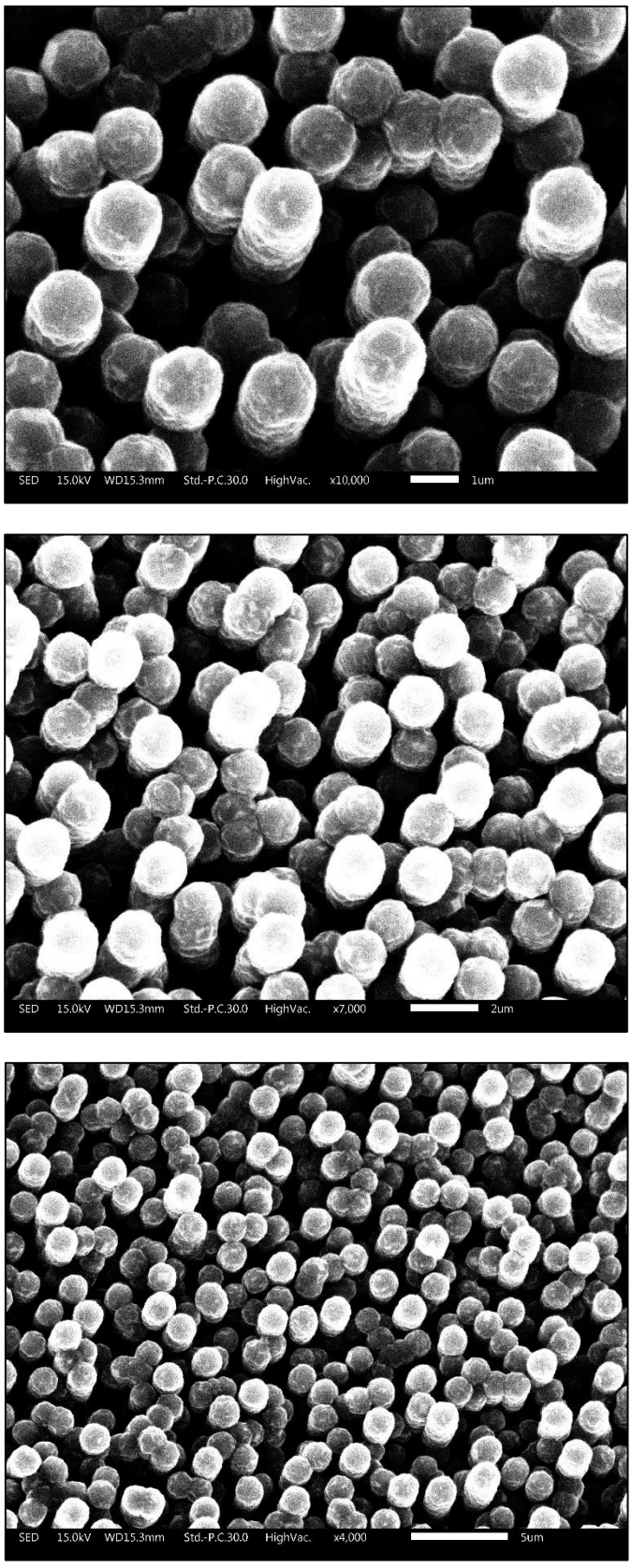


Figure 6: SEM images for large black silicon needles coated in a MCD film grown for 1 hour and 30 mins after electrospray pretreatment.



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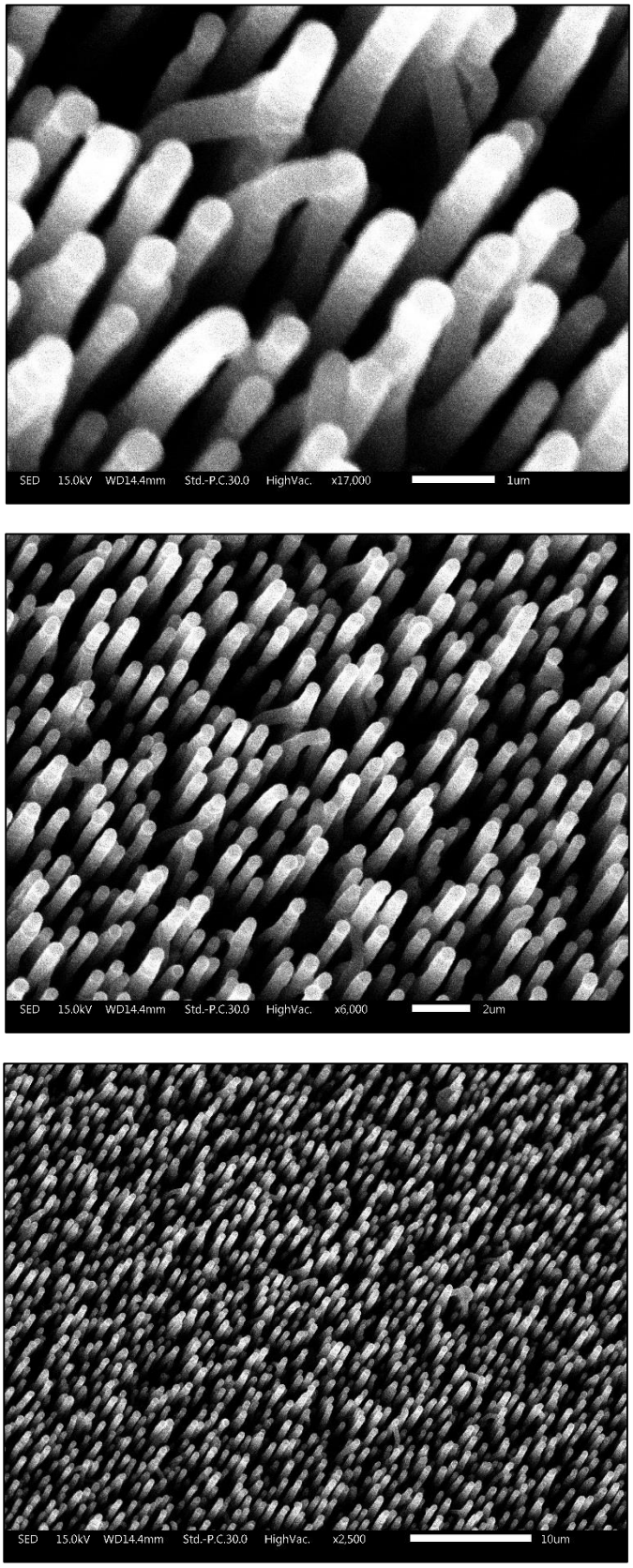

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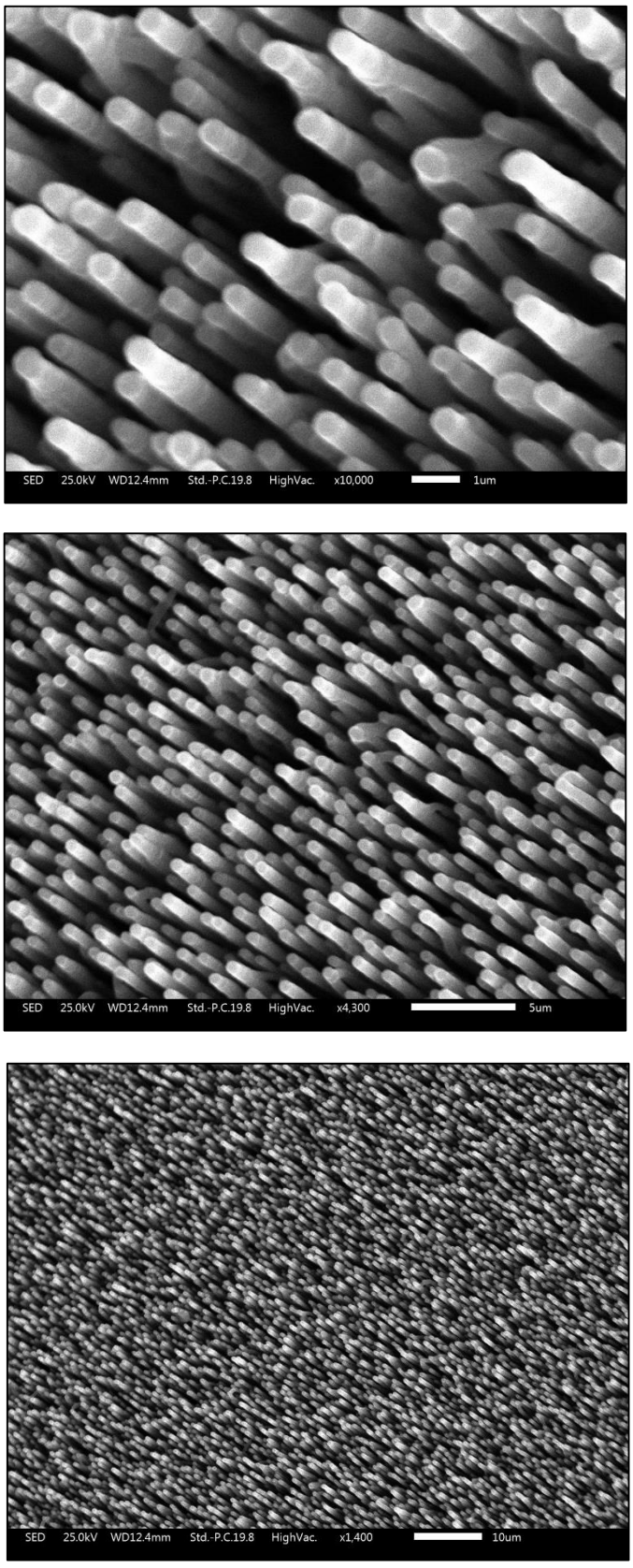

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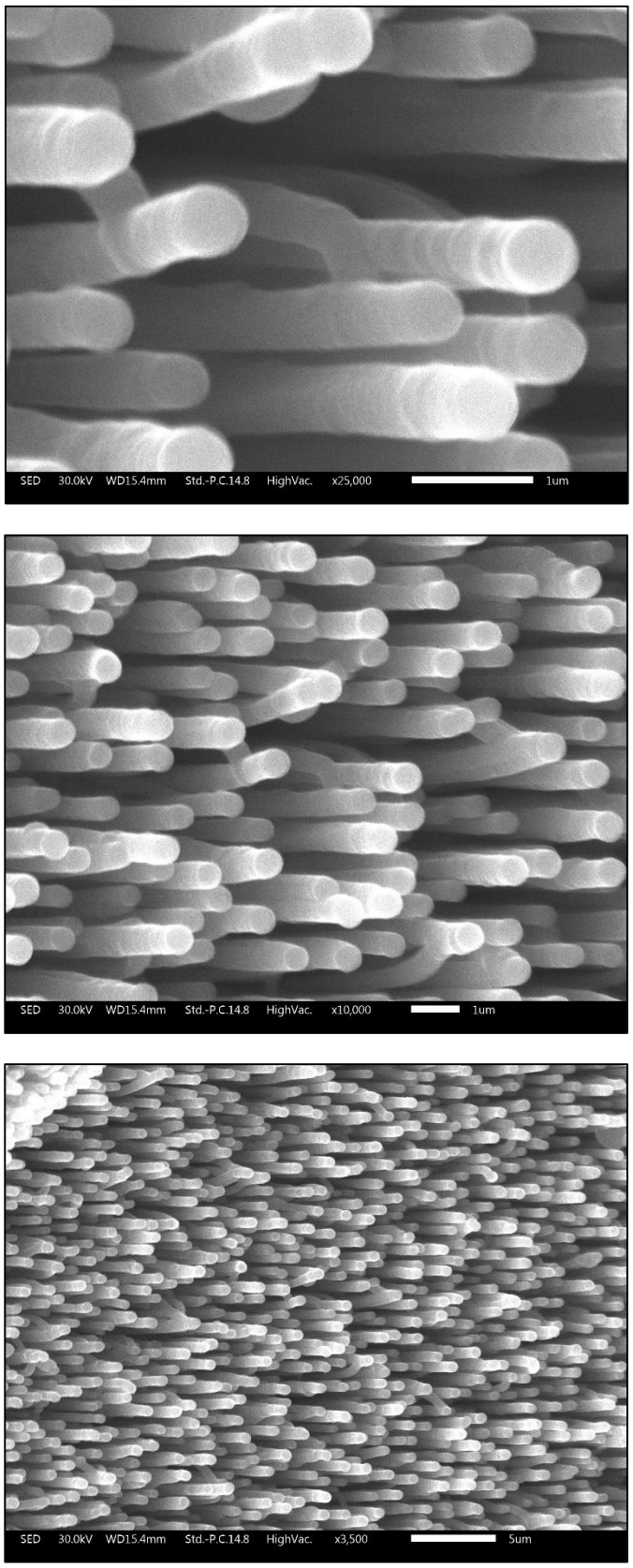
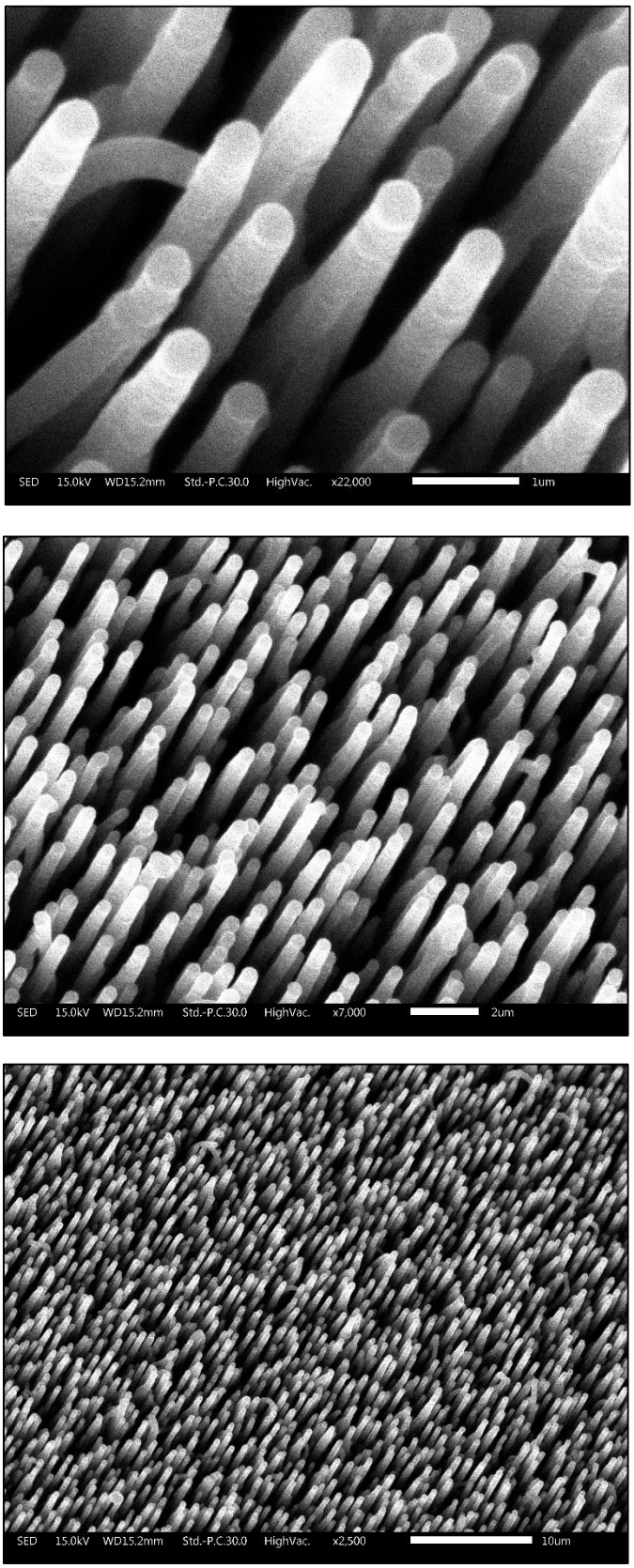


Figure 10: SEM images for large black silicon needles coated in a NCD film grown for 30 mins after electrospray pretreatment.



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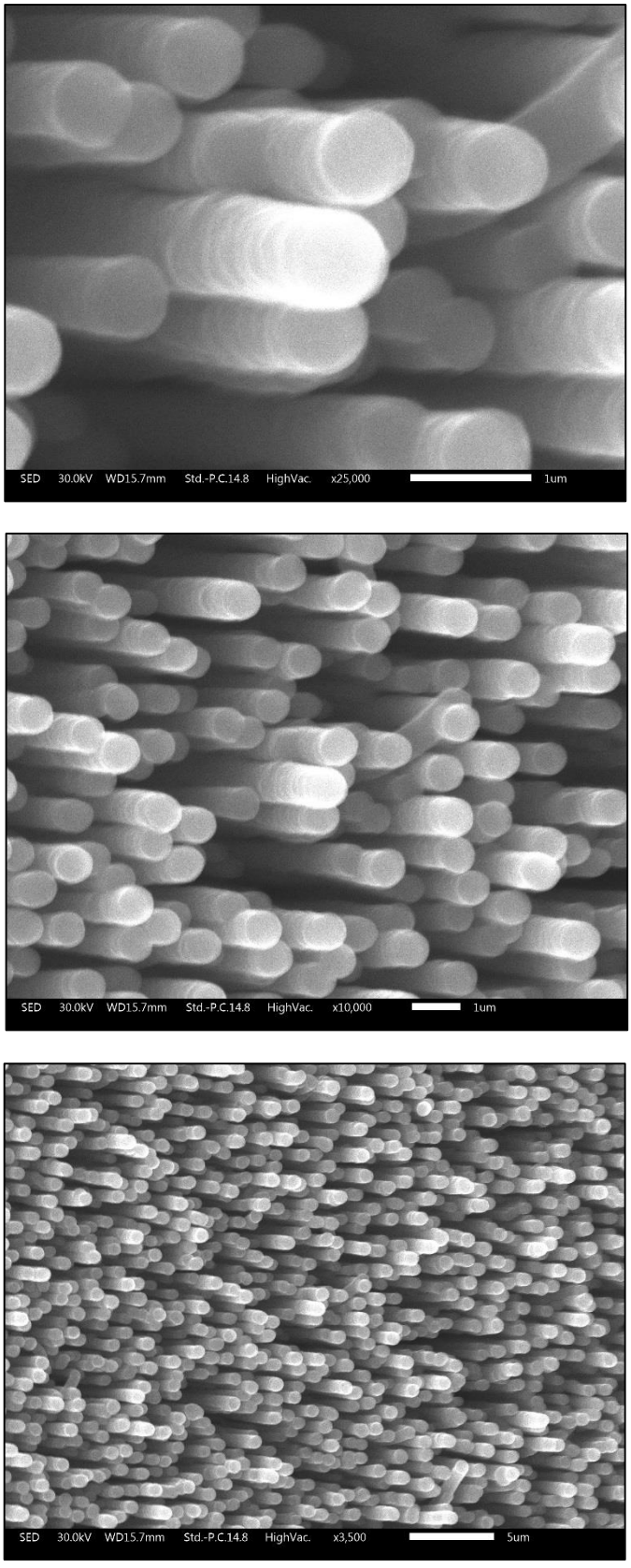


Figure 12: SEM images for large black silicon needles coated in a NCD film grown for 1 hour after electrospray pretreatment.

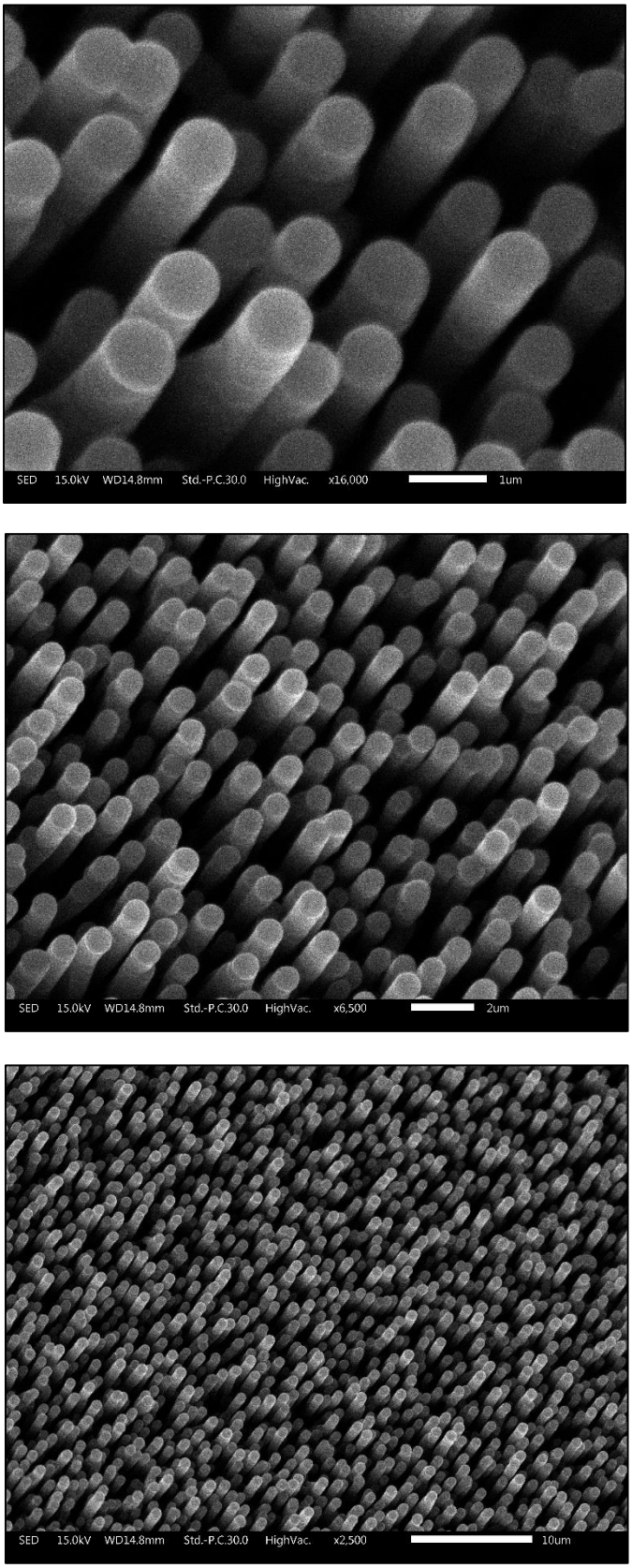


Figure 13: SEM images for large black silicon needles coated in a NCD film grown for 1 hour and 20 mins after electrospray pretreatment.

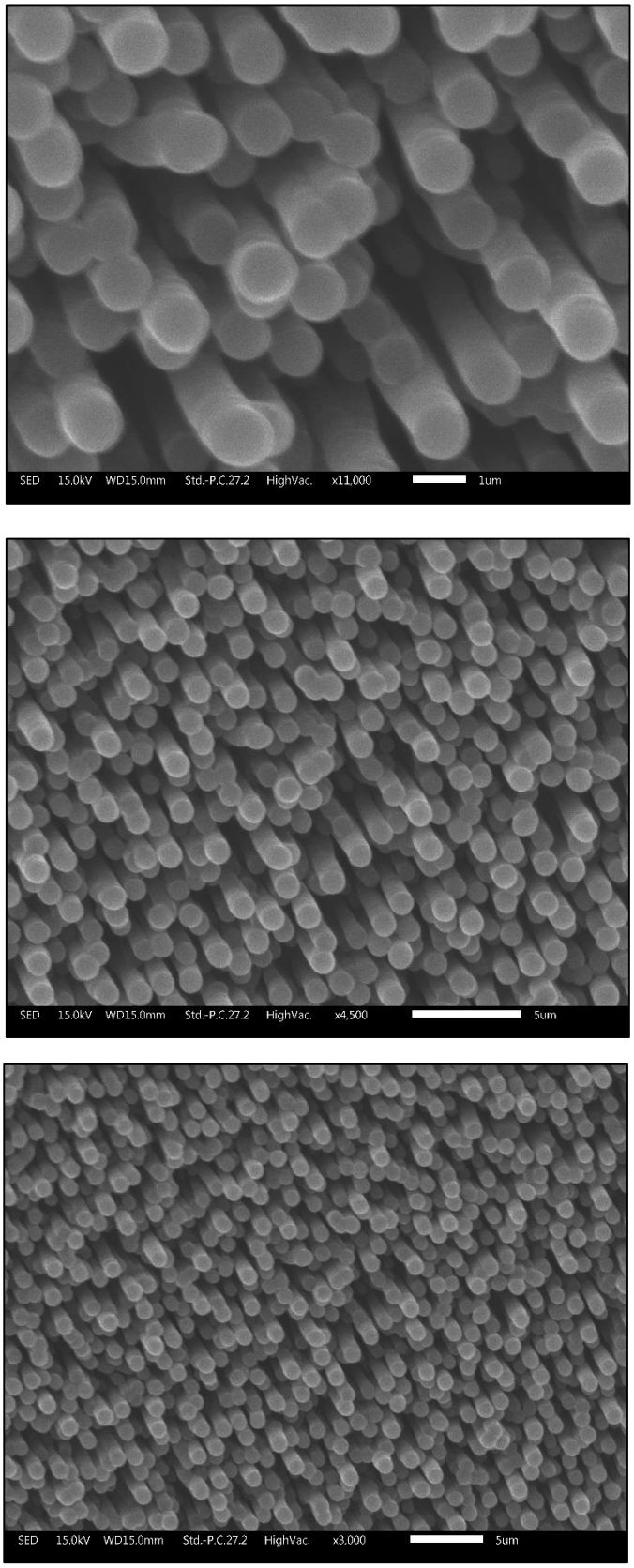


Figure 14: SEM images for large black silicon needles coated in a NCD film grown for 2 hours after electrospray pretreatment.

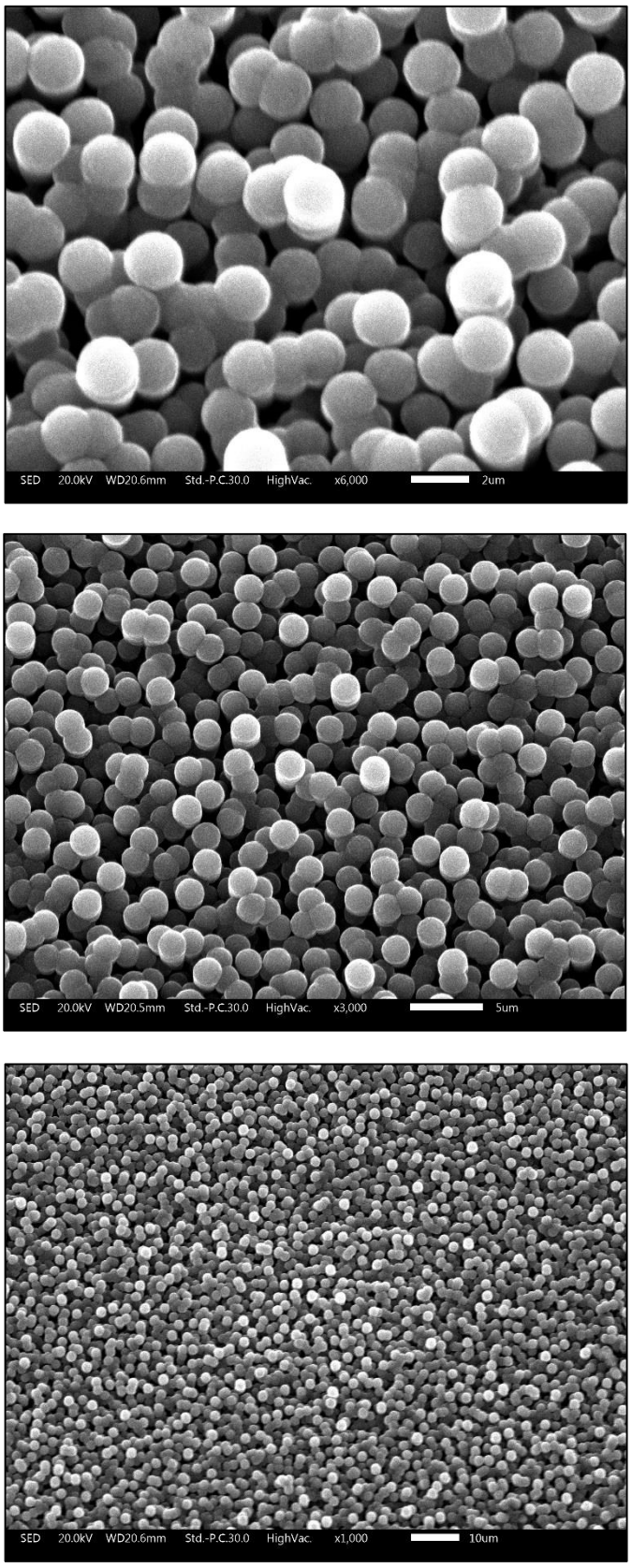
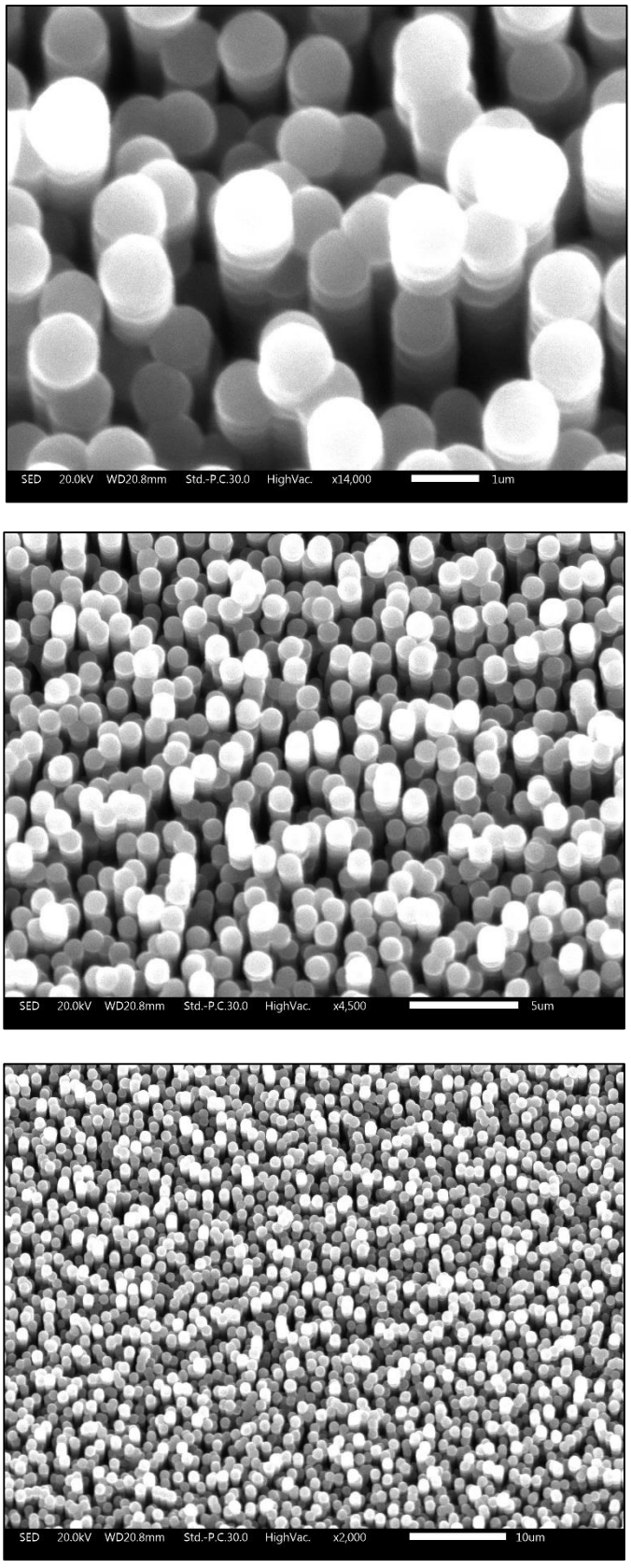


Figure 15: SEM images for large black silicon needles coated in a NCD film grown for 3 hours after electrospray pretreatment.



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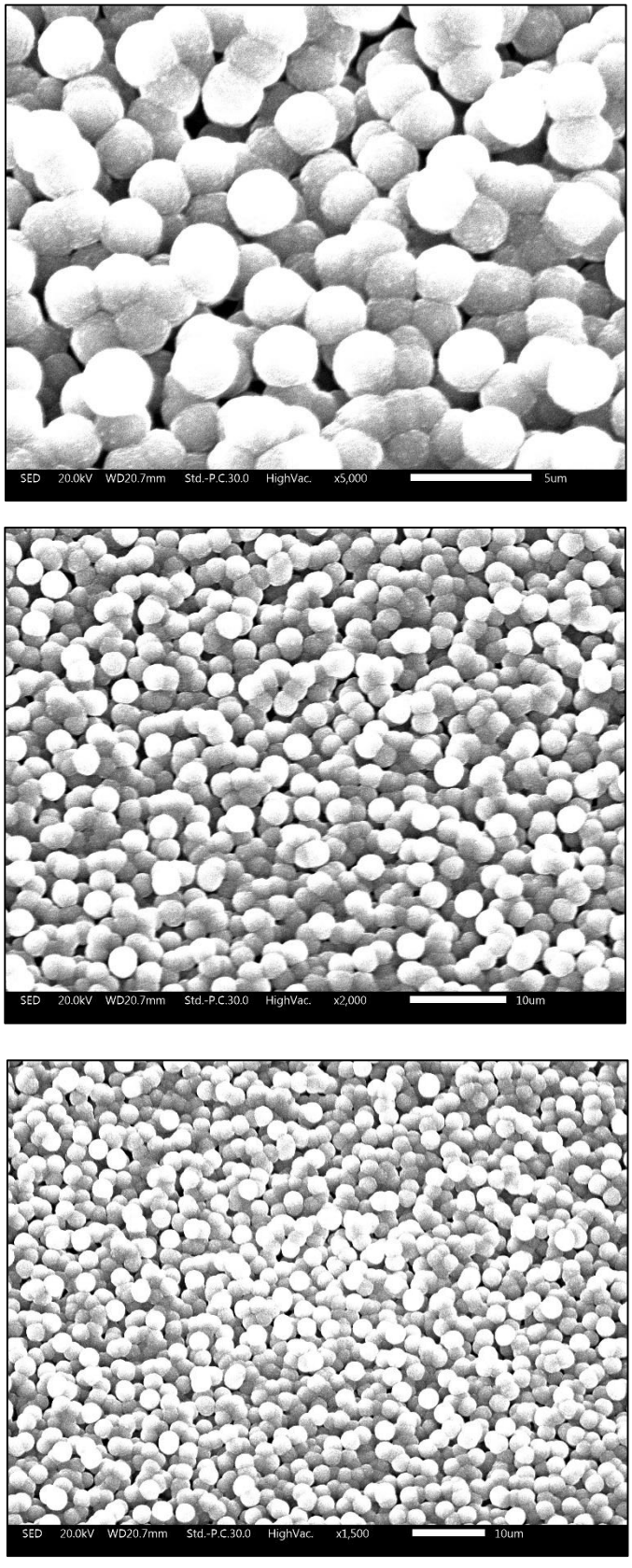

Figure 17: SEM images for large black silicon needles coated in a NCD film grown for 4 hours after electrospray pretreatment.

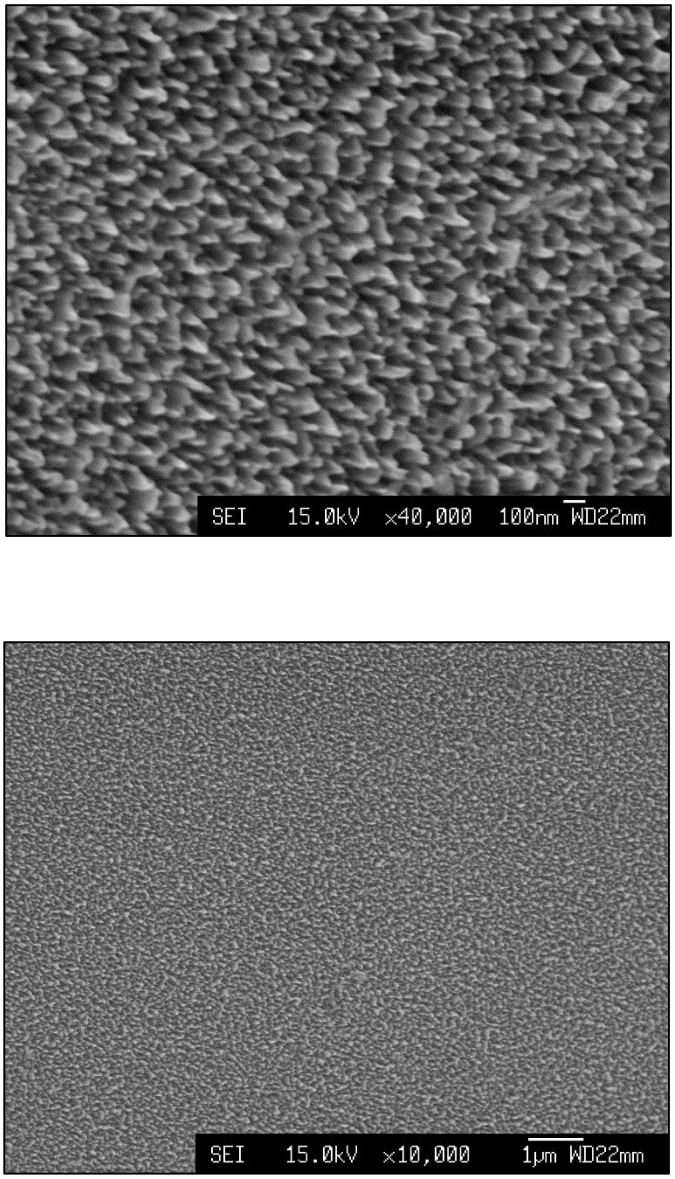

Figure 18: SEM images for uncoated small black silicon needles.

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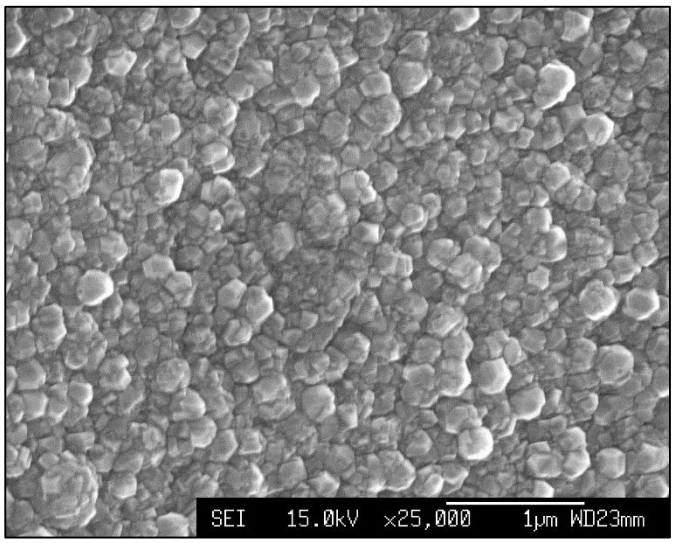

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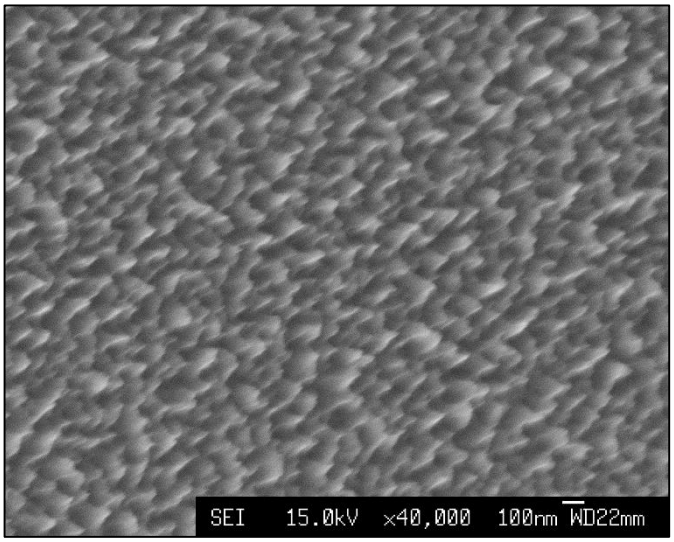

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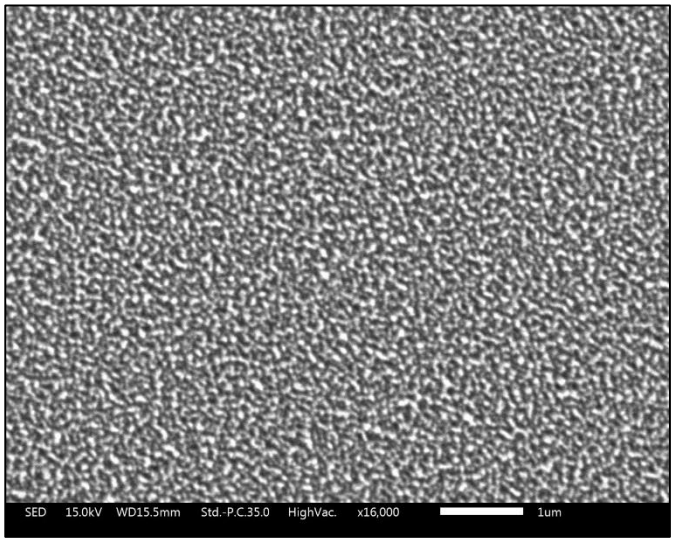


Figure 19: SEM images for small black silicon needles coated in a MCD film grown for a) 30 mins after electrospray pretreatment, b) 30 mins and c) 45 mins.

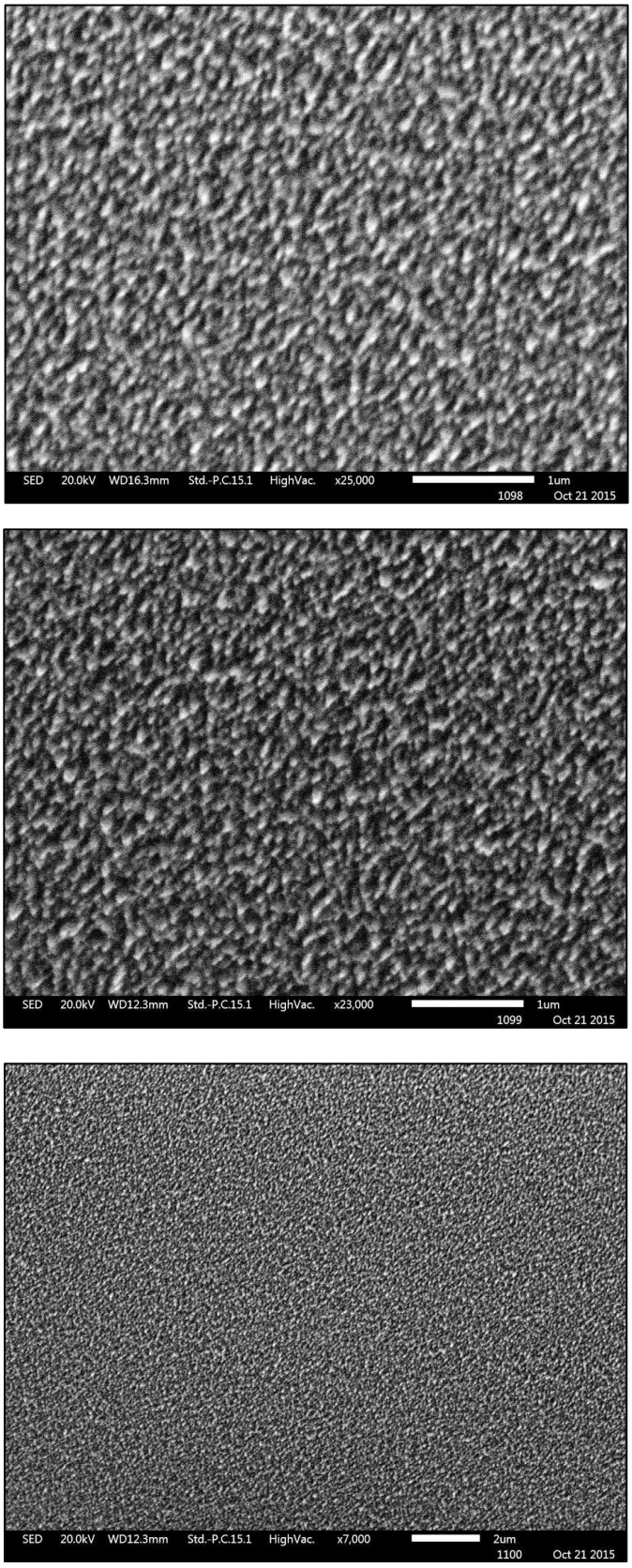
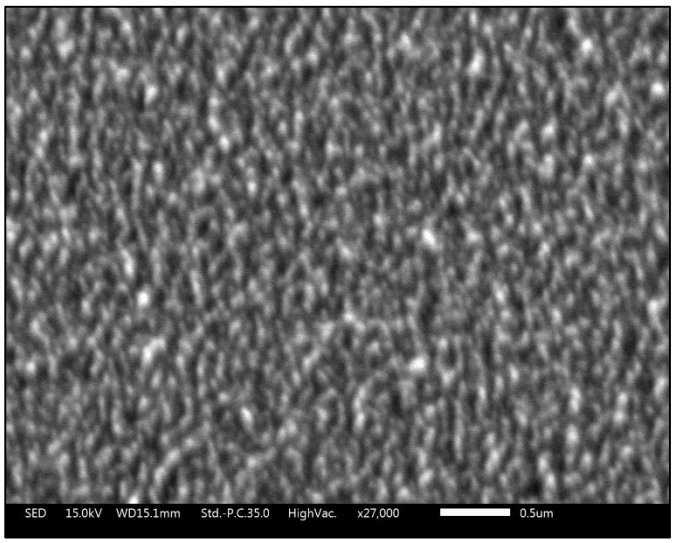


Figure 20: SEM images for small black silicon needles coated in a MCD film grown for 1 hour.

a)



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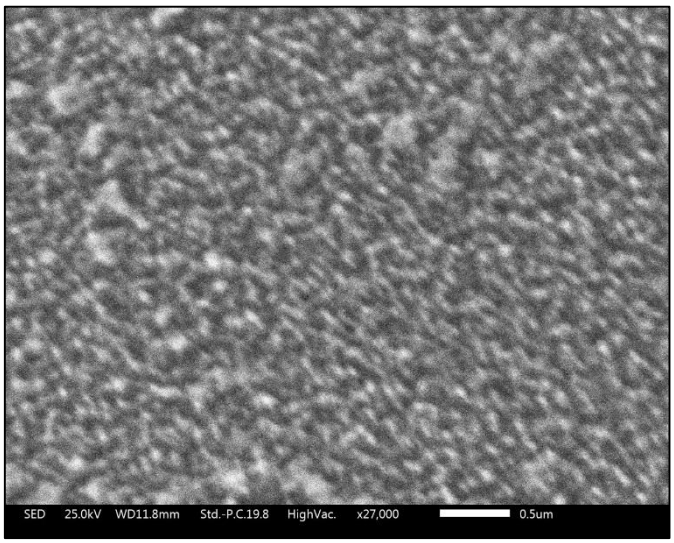

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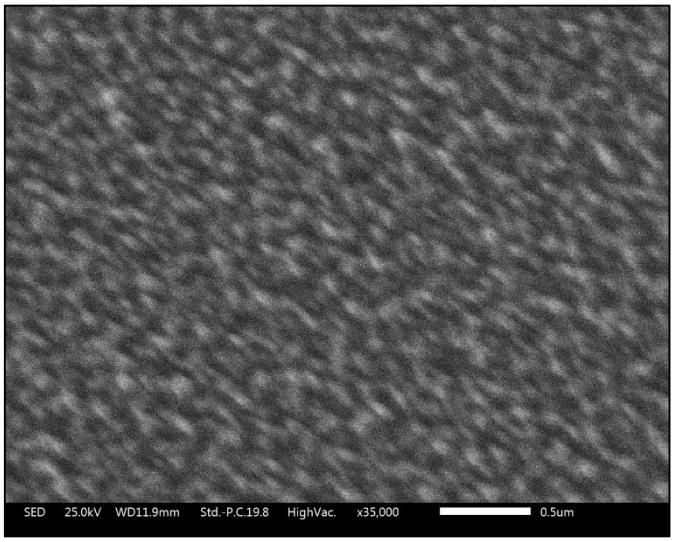


Figure 21: SEM images for small black silicon needles coated in a MCD film grown for a) 1 hour 30 mins, b) 2 hours, and c) NCD film grown for 1 hour.

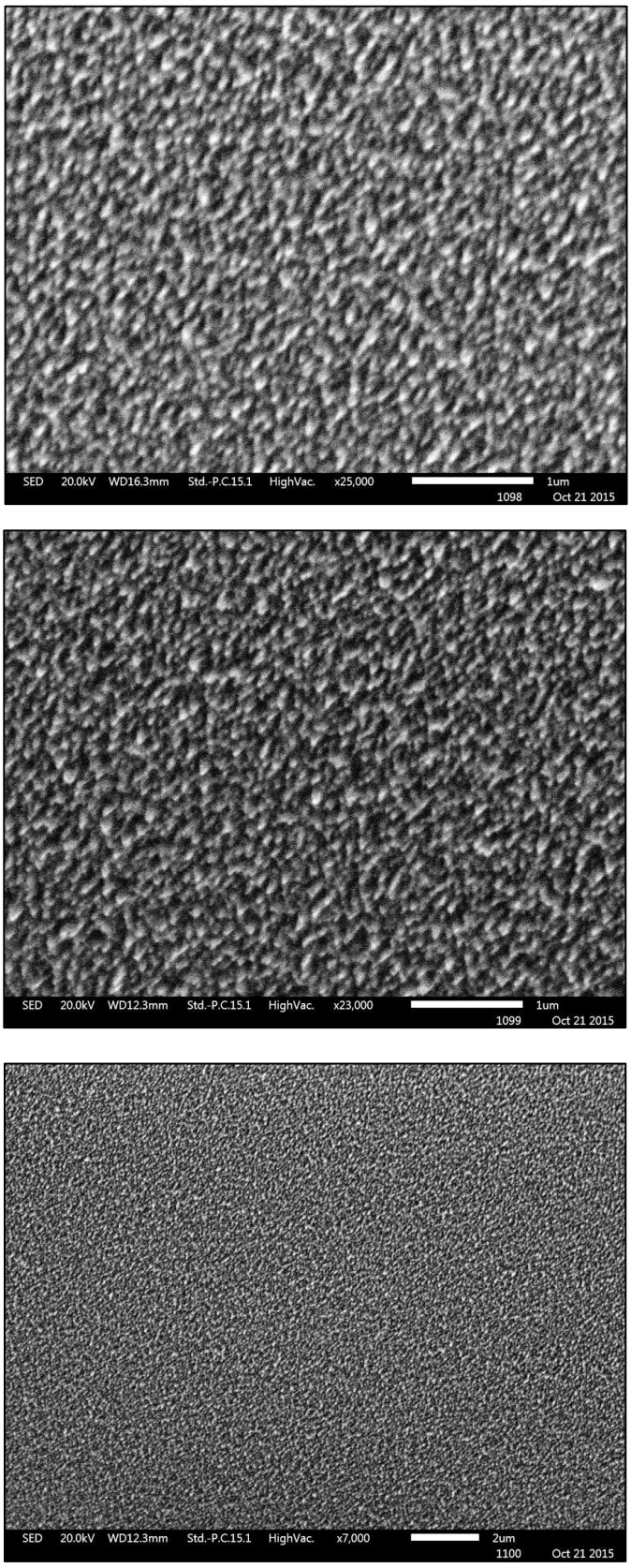


Figure 22: SEM images for small black silicon needles coated in a MCD film grown for 1 hour.

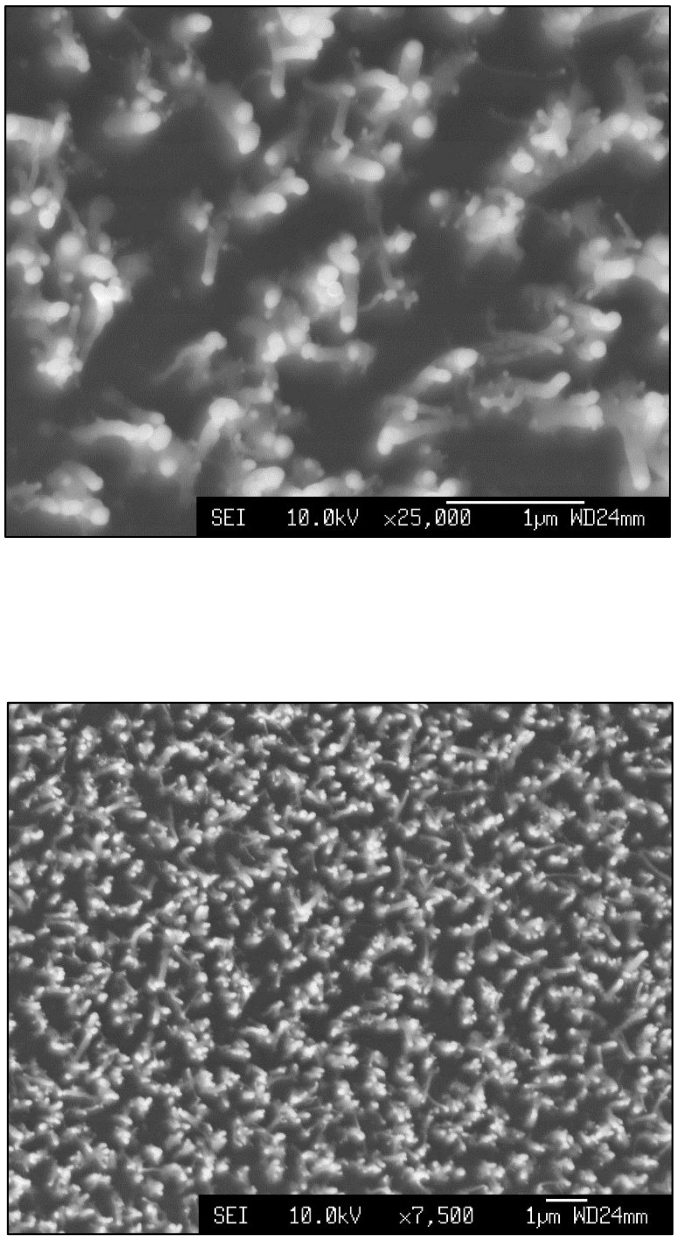


Figure 23: SEM images for vertically aligned carbon nanotubes (VACNTs) viewed from above.

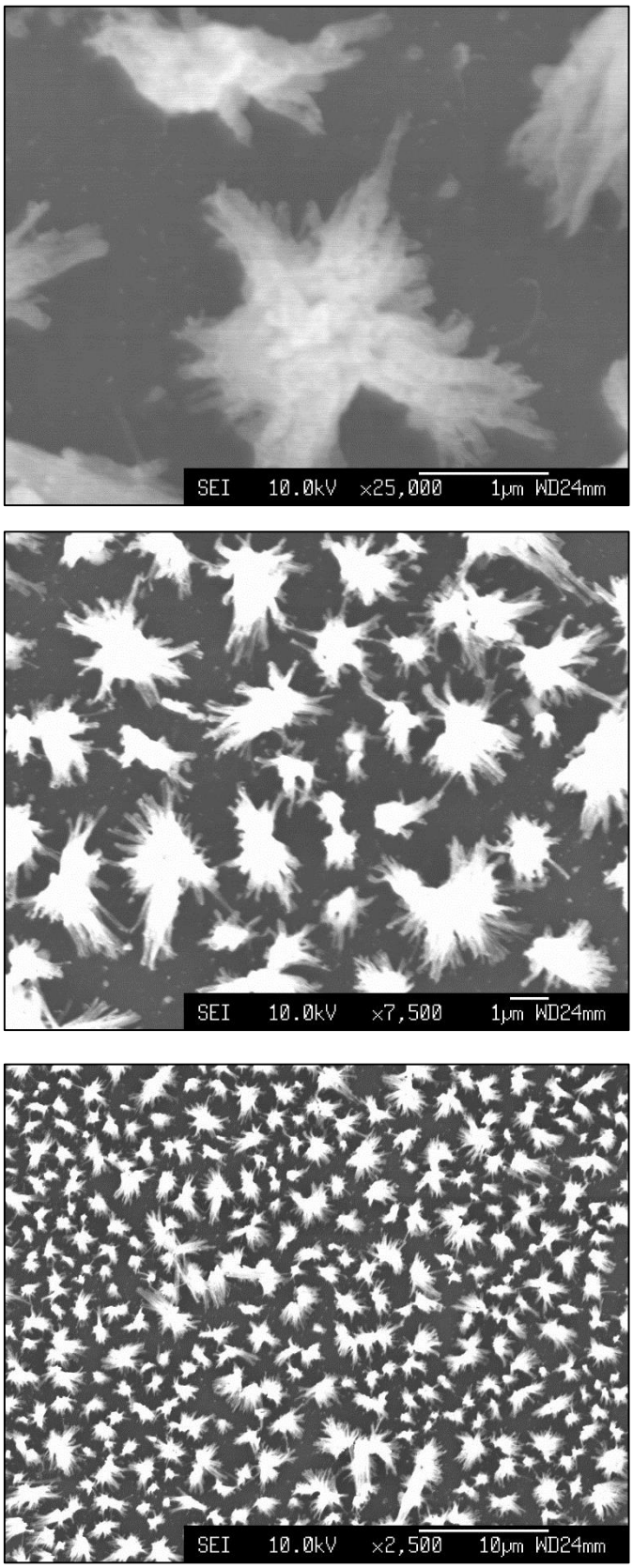


Figure 24: SEM images for VACNT teepees after electrospray pretreatment viewed from above.

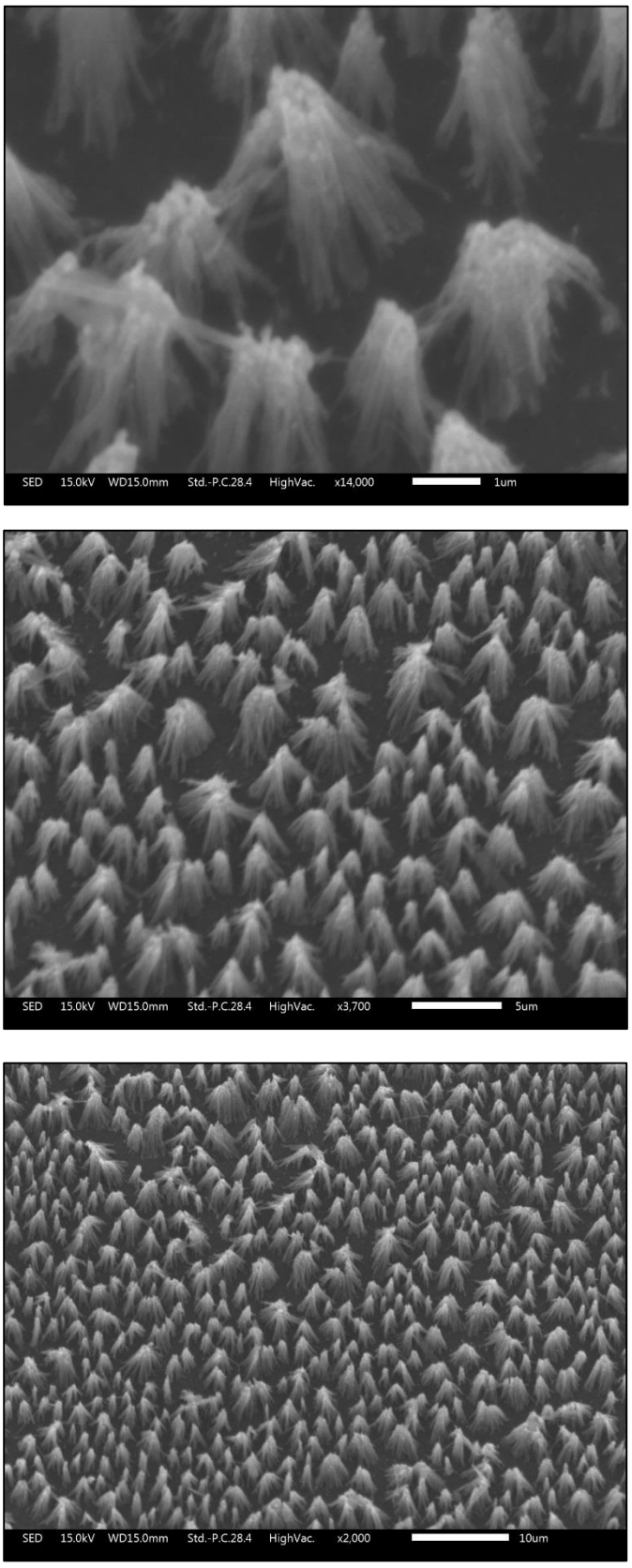


Figure 25: SEM images for VACNT teepees after electrospray pretreatment viewed from tilted angle.

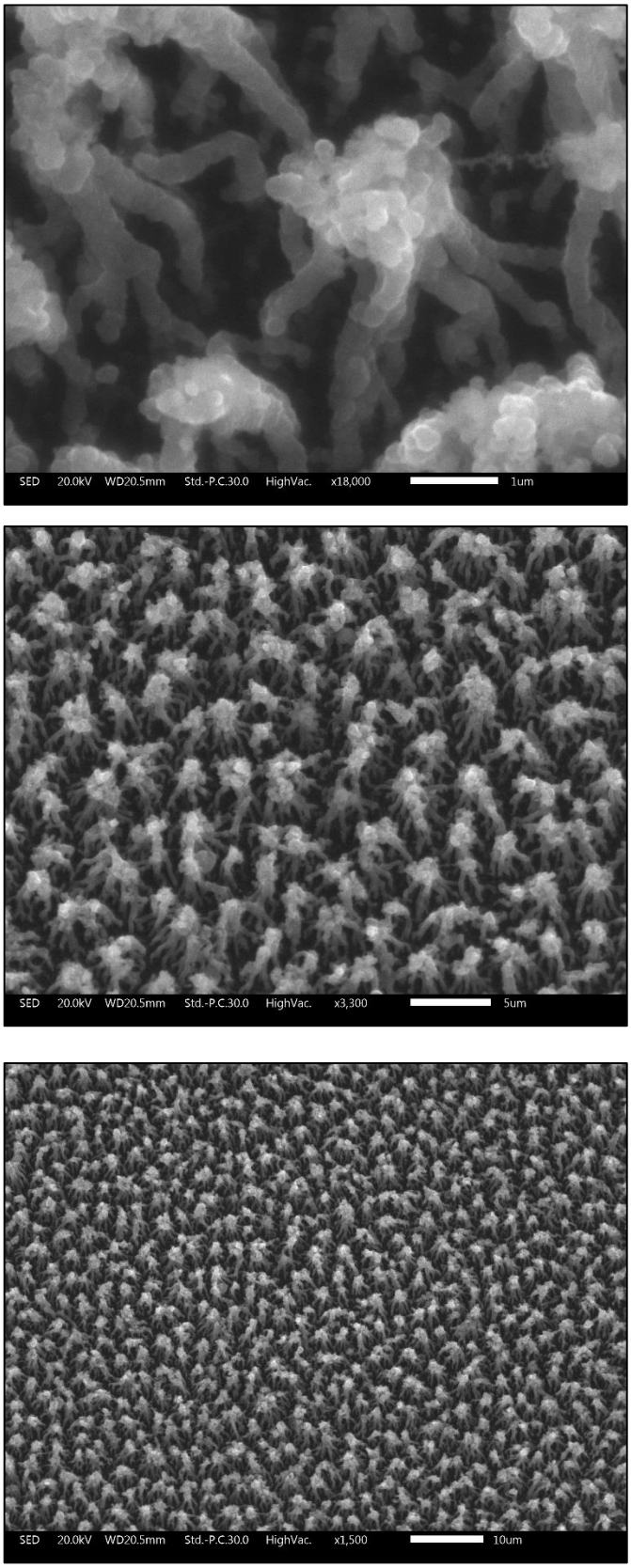


Figure 26: SEM images viewed from tilted angle for VACNT teepees coated in MCD film grown for 20 mins after electrospray pretreatment.

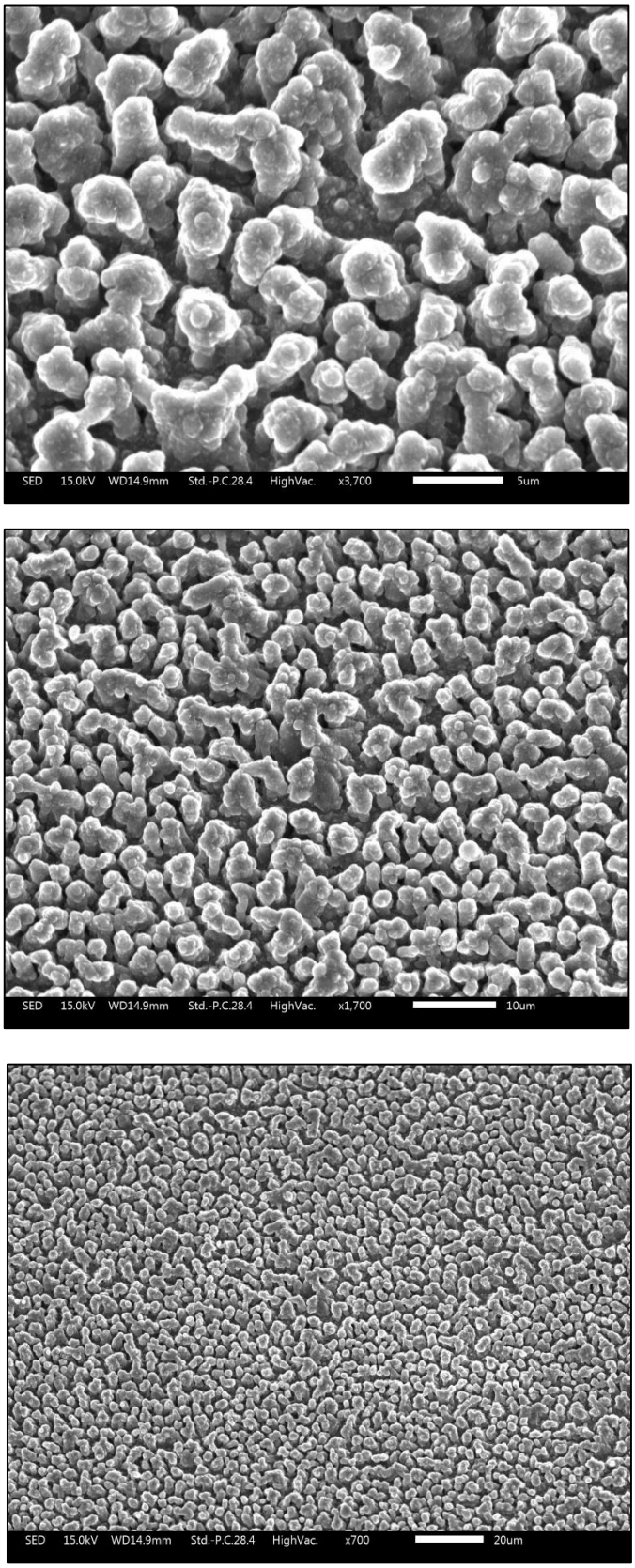
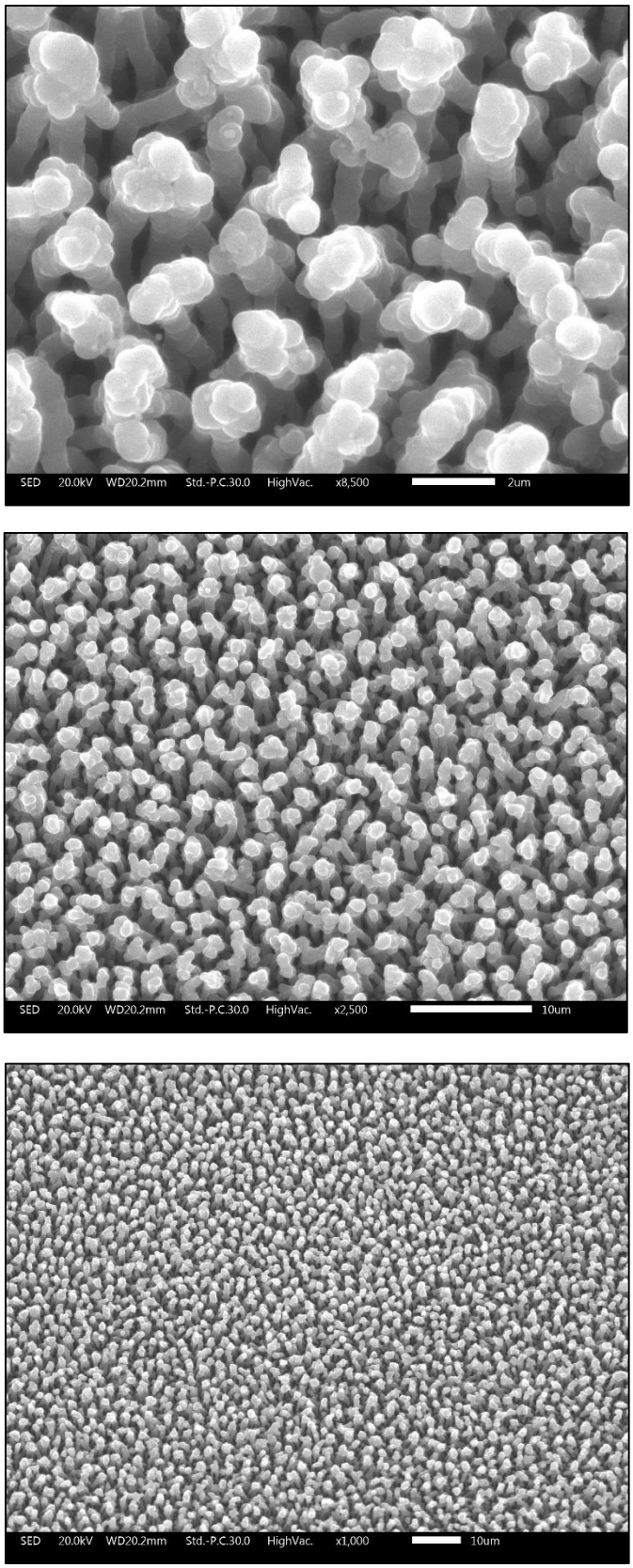


Figure 27: SEM images viewed from tilted angle for VACNT teepees coated in MCD film grown for 45 mins after electrospray pretreatment.



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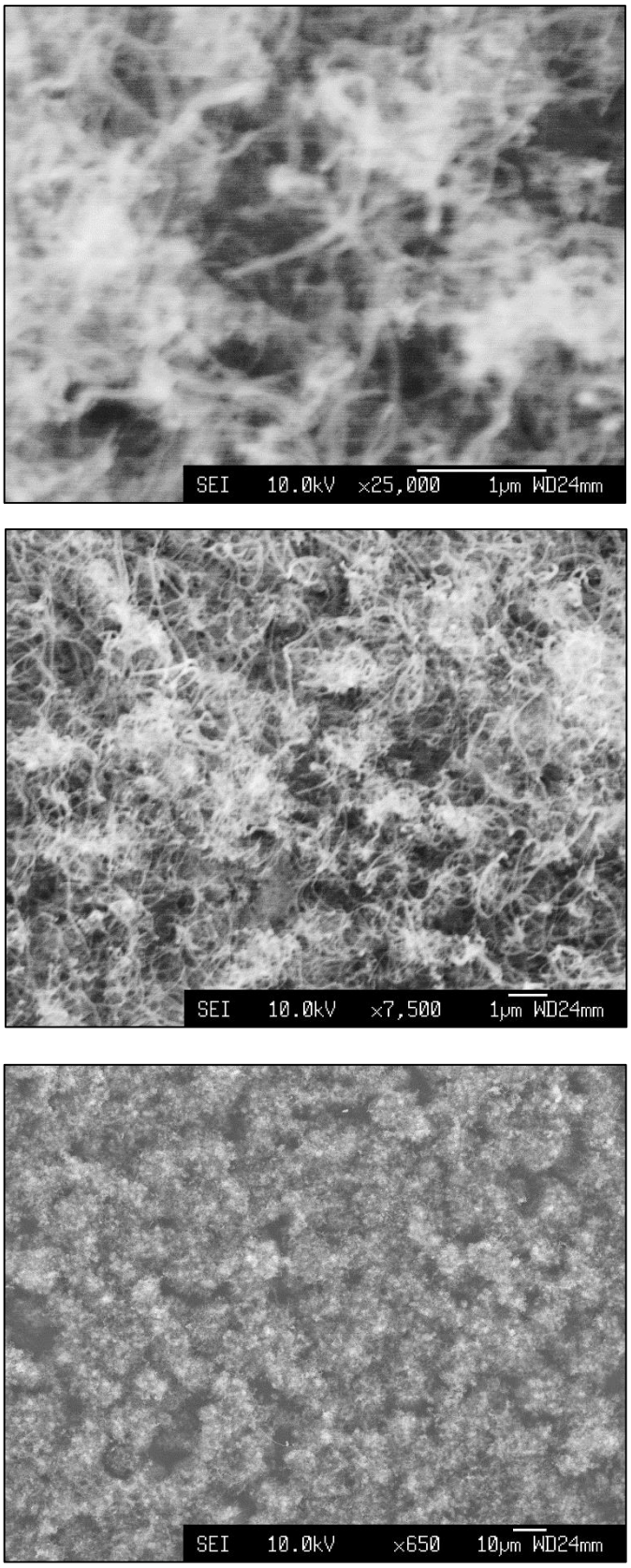


Figure 29: SEM images for uncoated carbon nanotube (CNT) webs.

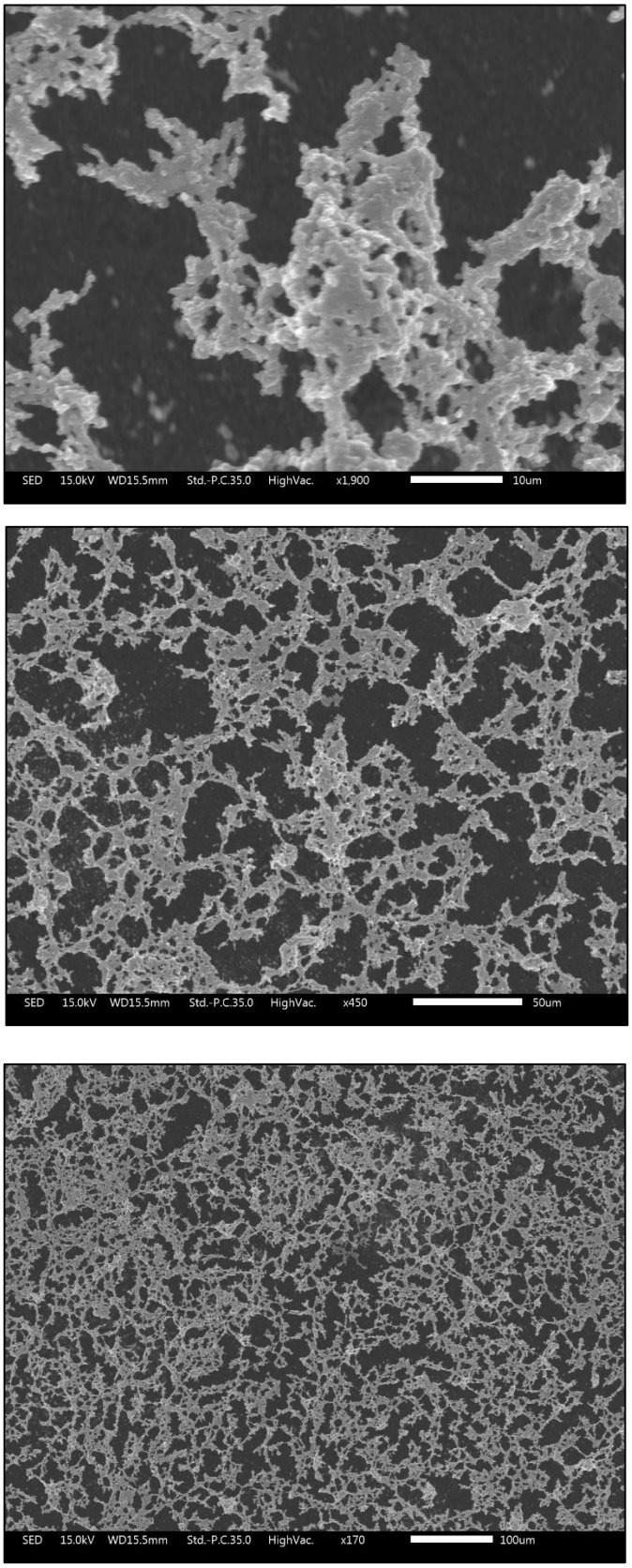
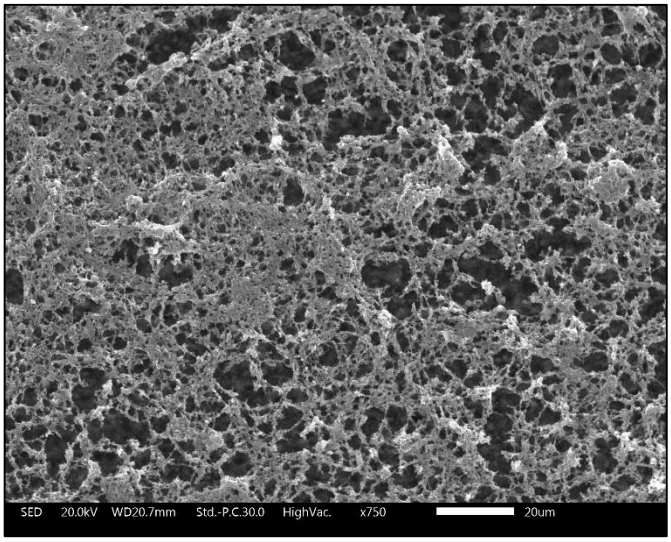


Figure 30: SEM images for carbon nanotube (CNT) webs coated in a MCD film grown for 30 mins after electrospray pretreatment.

a)



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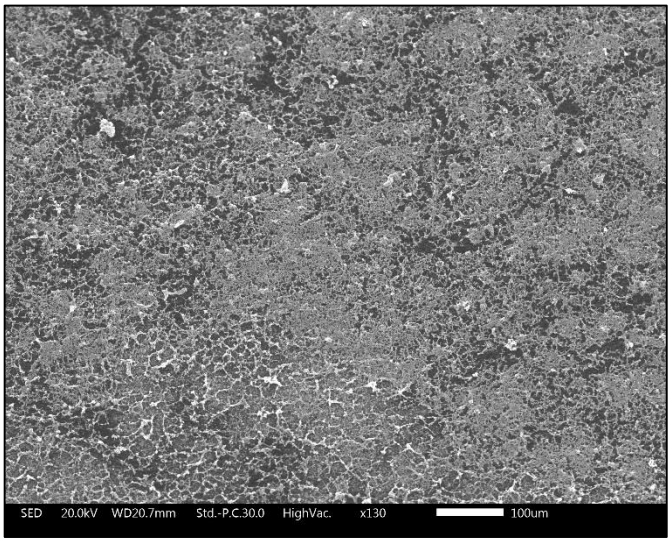

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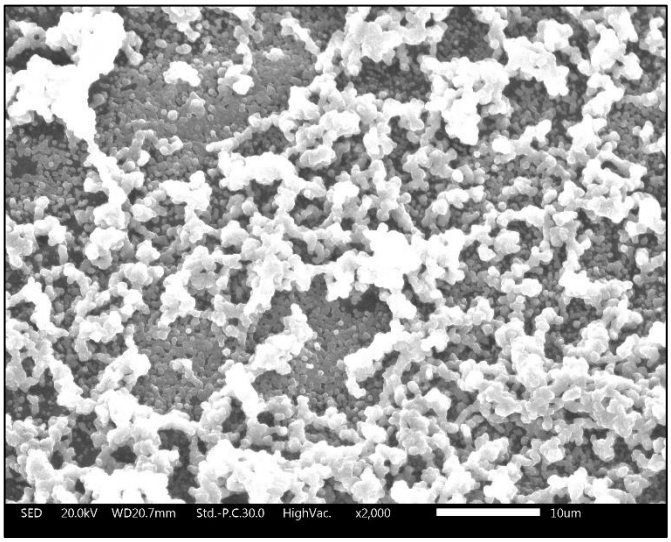

Figure 31: SEM images for carbon nanotube (CNT) webs coated in a MCD film grown for a) & b) 20 mins and c) NCD film grown for 45 mins, after electrospray pretreatment.

Raman Spectroscopy

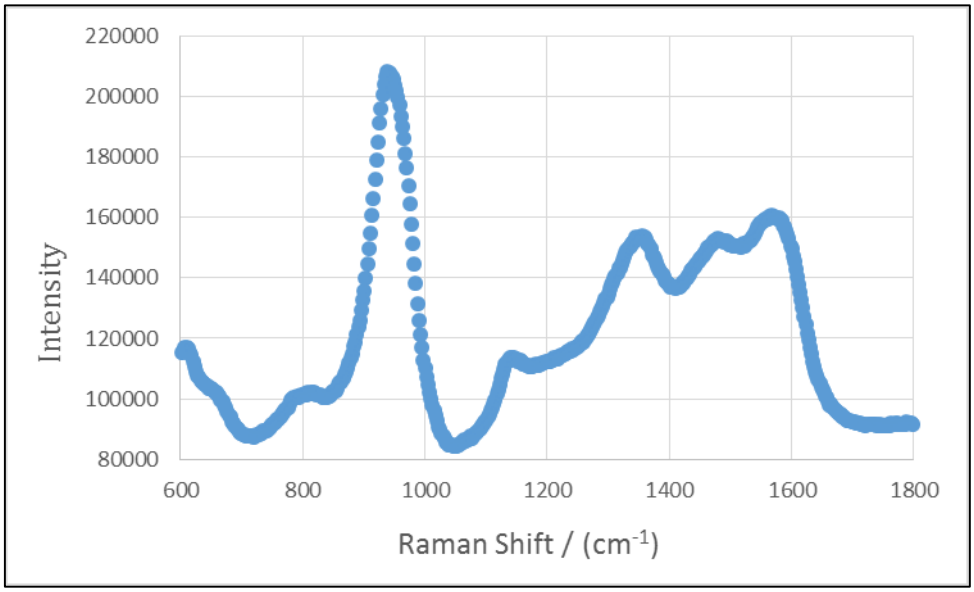

Figure 32: Raman spectra recorded for large silicon needles coated in a MCD film grown for 20 mins after electrospray pretreatment.

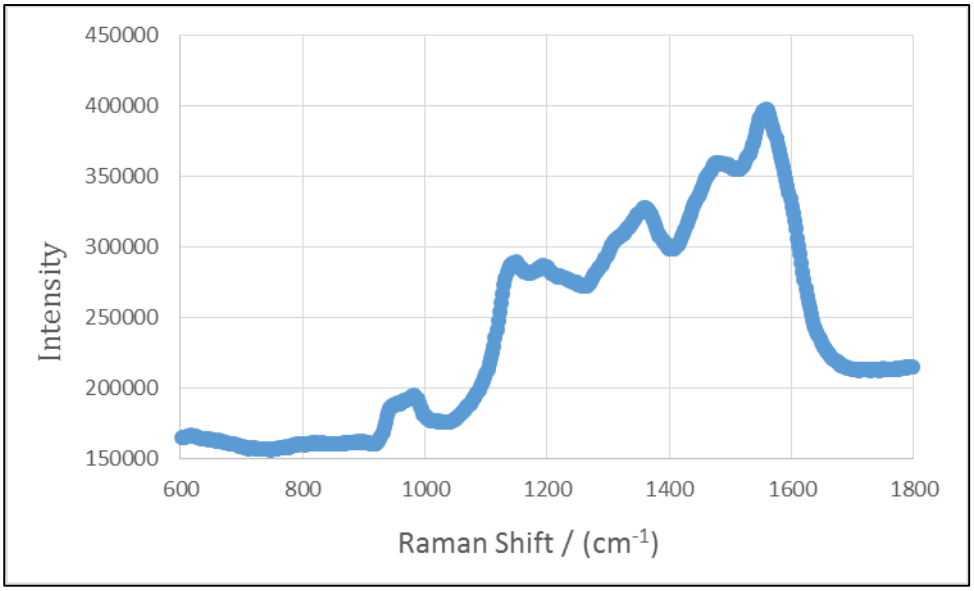

Figure 33: Raman spectra recorded for large silicon needles coated in a MCD film grown for 30 mins after electrospray pretreatment.

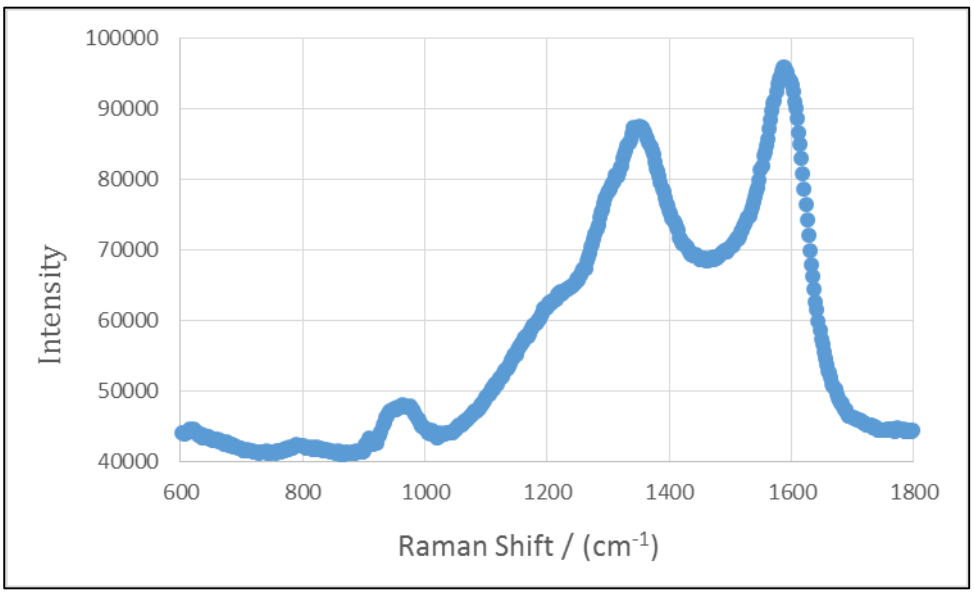

Figure 34: Raman spectra recorded for large silicon needles coated in a MCD film grown for 45 mins after electrospray pretreatment.

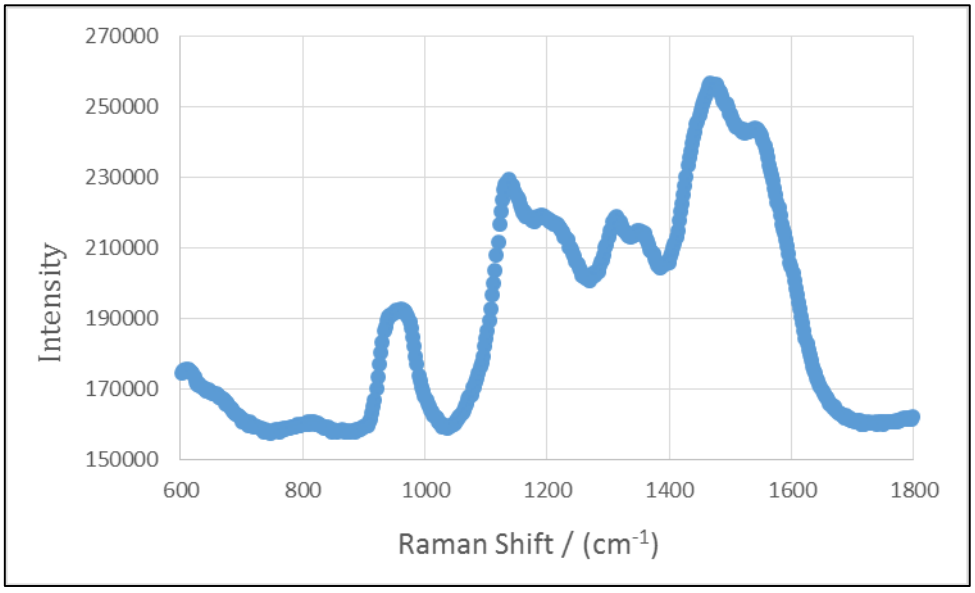

Figure 35: Raman spectra recorded for large silicon needles coated in a MCD film grown for 1 hour after electrospray pretreatment.

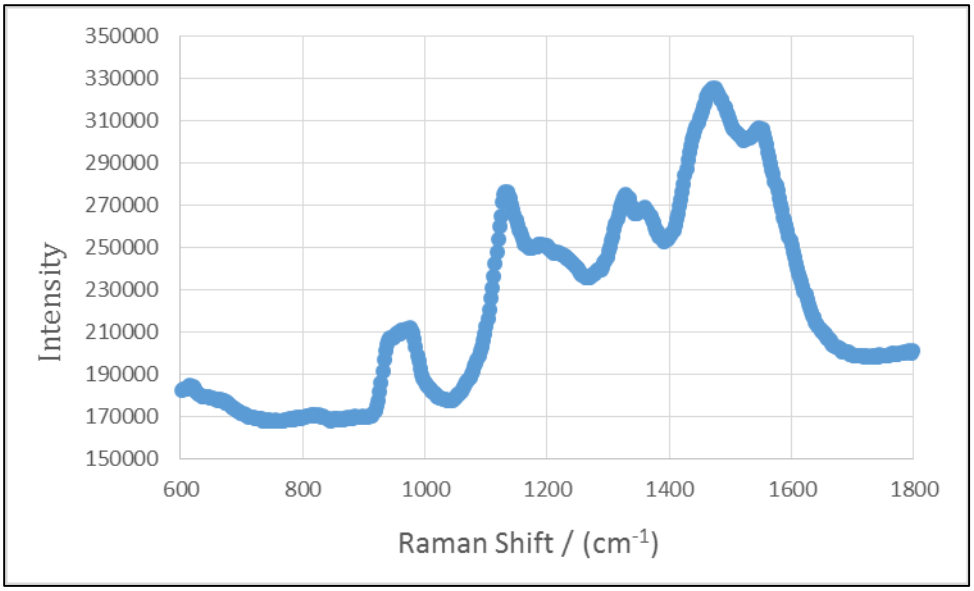

Figure 36: Raman spectra recorded for large silicon needles coated in a MCD film grown for 1 hour 30 mins after electrospray pretreatment.

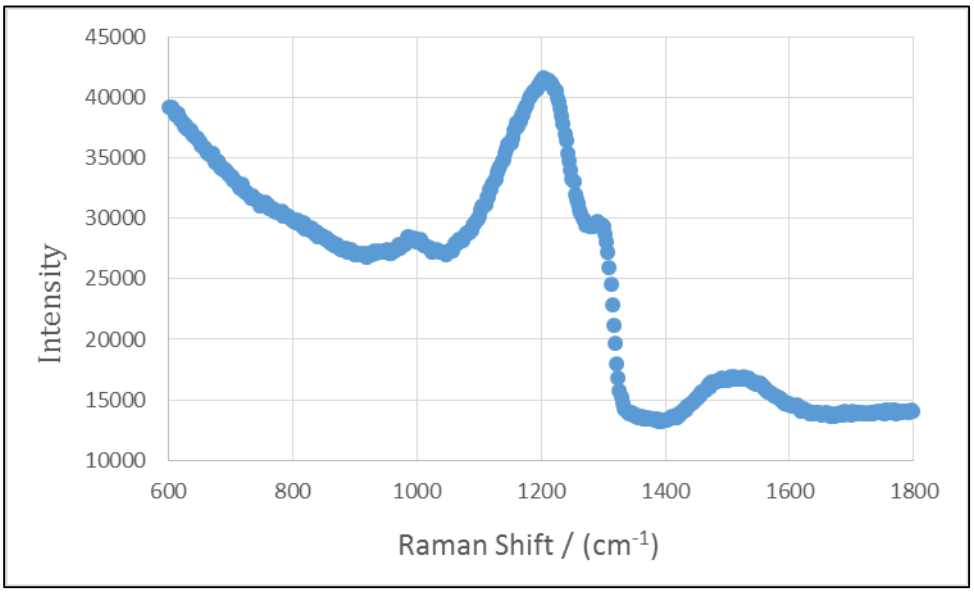

Figure 37: Raman spectra recorded for large silicon needles coated in a MCD film grown for 2 hours after electrospray pretreatment.

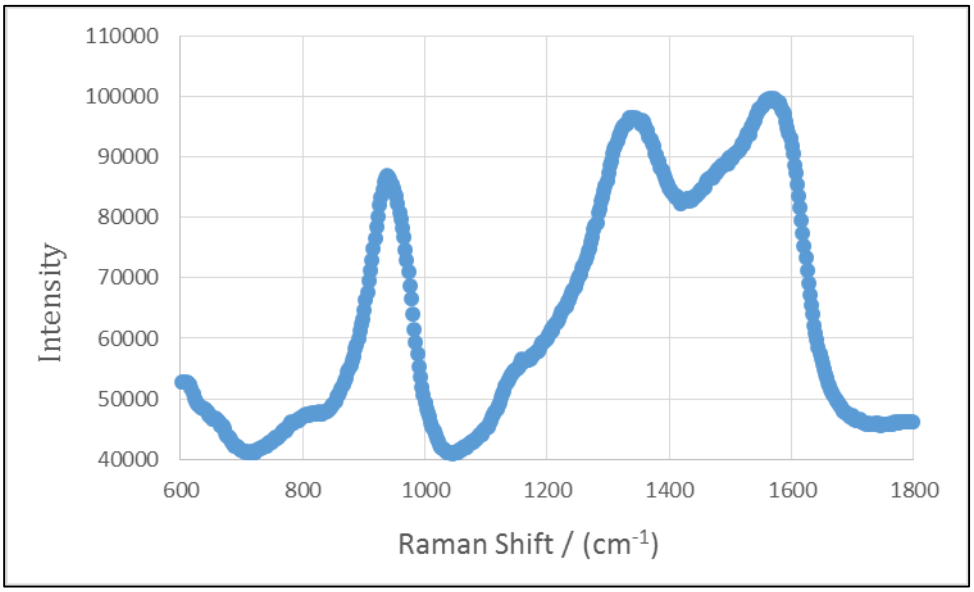

Figure 38: Raman spectra recorded for large silicon needles coated in a NCD film grown for 15 mins after electrospray pretreatment.

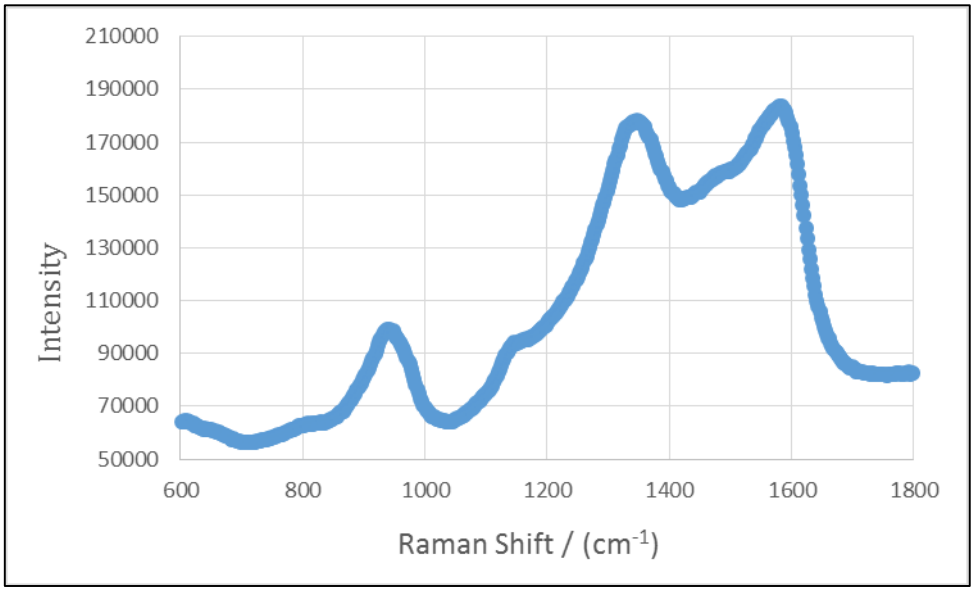

Figure 39: Raman spectra recorded for large silicon needles coated in a NCD film grown for 20 mins after electrospray pretreatment.

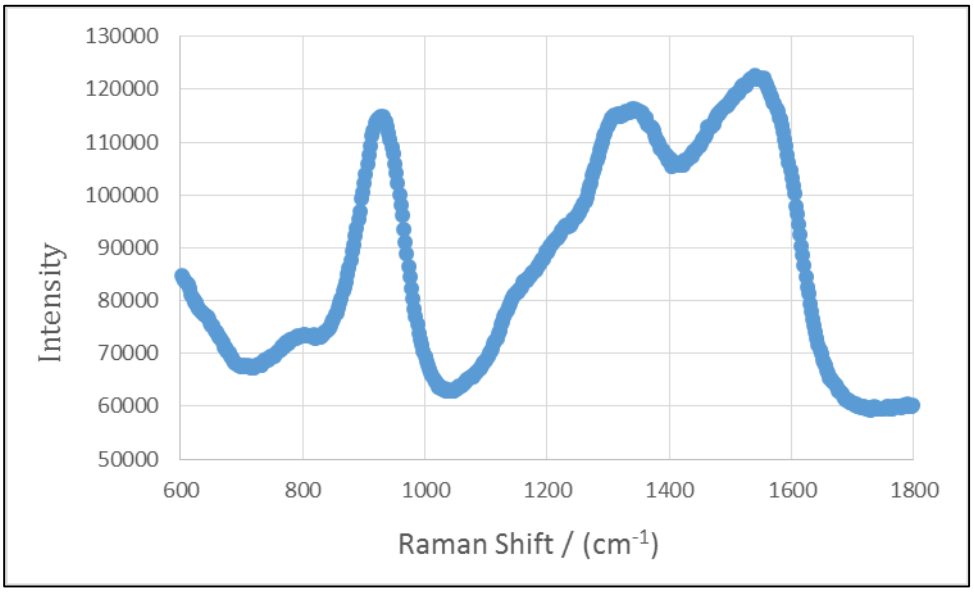

Figure 40: Raman spectra recorded for large silicon needles coated in a NCD film grown for 30 mins after electrospray pretreatment.

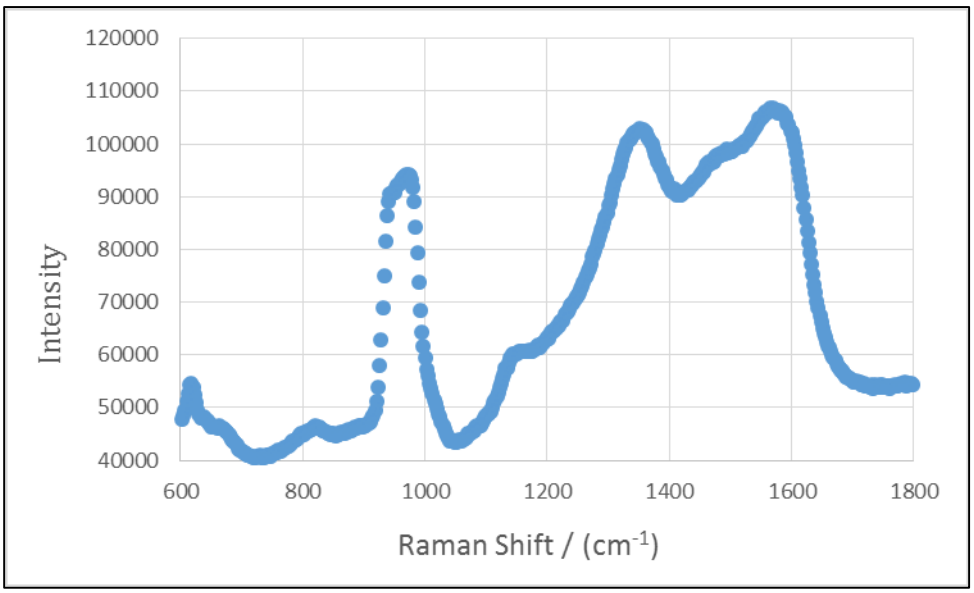

Figure 41: Raman spectra recorded for large silicon needles coated in a NCD film grown for 40 mins after electrospray pretreatment.

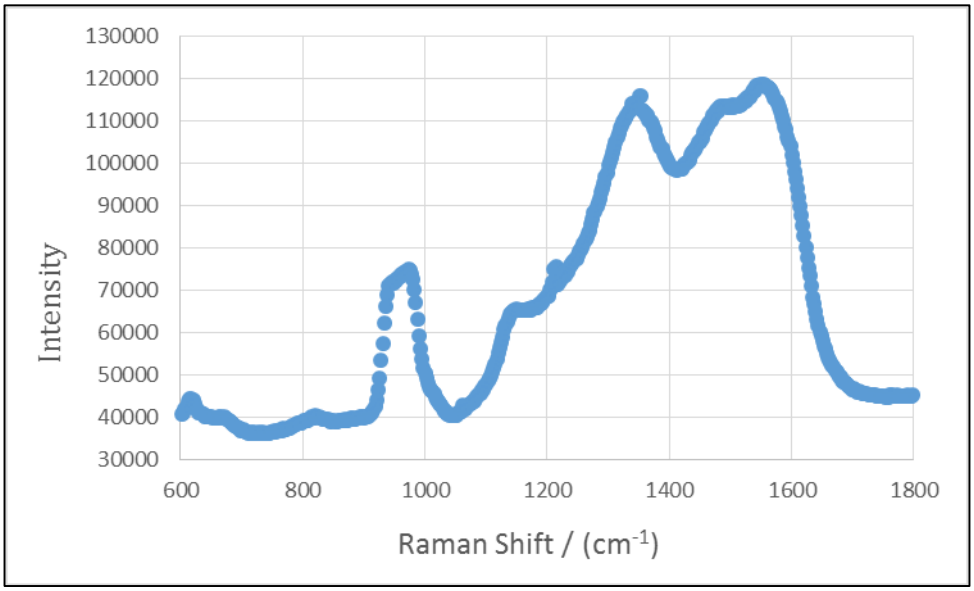

Figure 42: Raman spectra recorded for large silicon needles coated in a NCD film grown for 1 hour 20 mins after electrospray pretreatment.

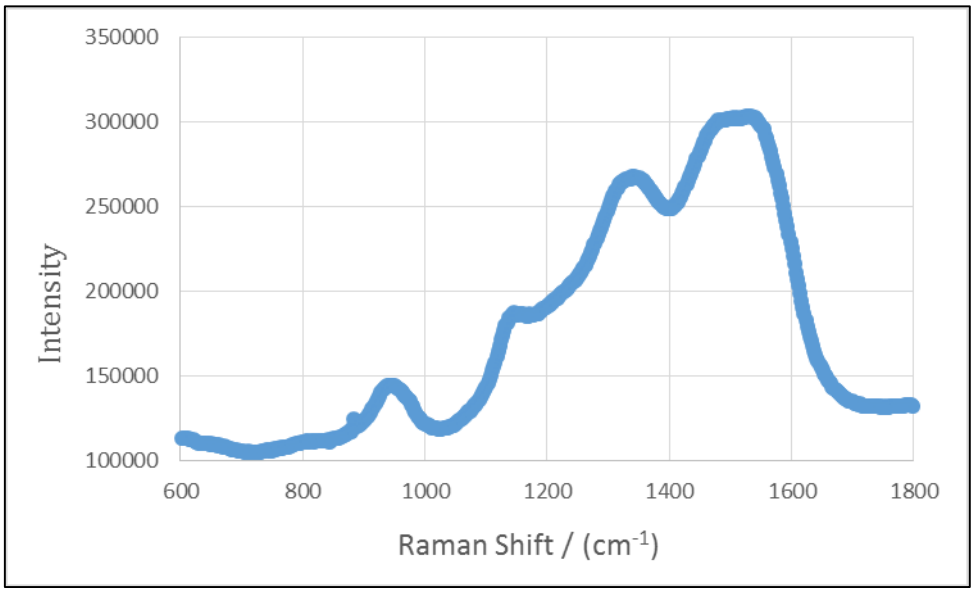

Figure 43: Raman spectra recorded for large silicon needles coated in a NCD film grown for 2 hours after electrospray pretreatment.

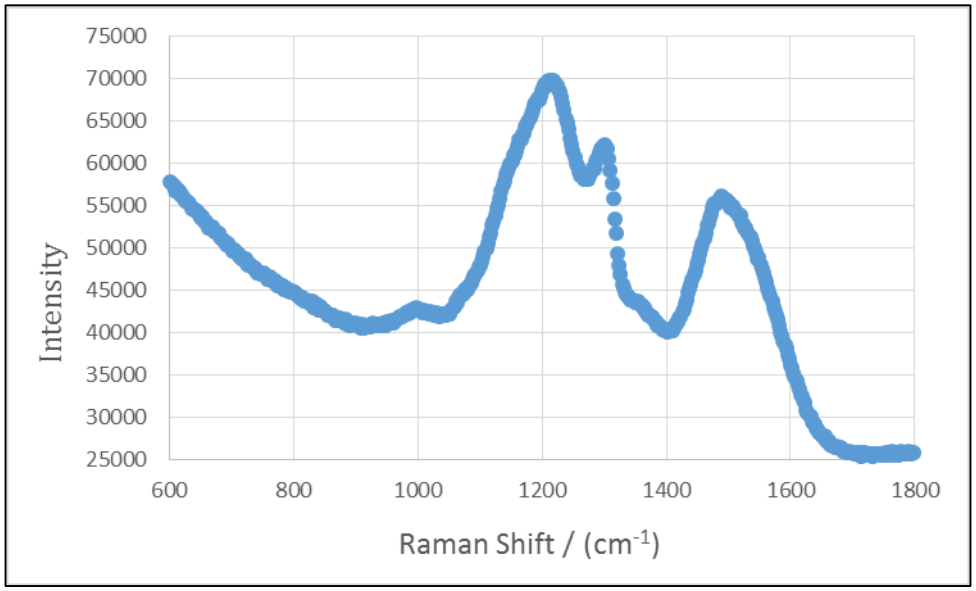

Figure 44: Raman spectra recorded for large silicon needles coated in a NCD film grown for 3 hours after electrospray pretreatment.

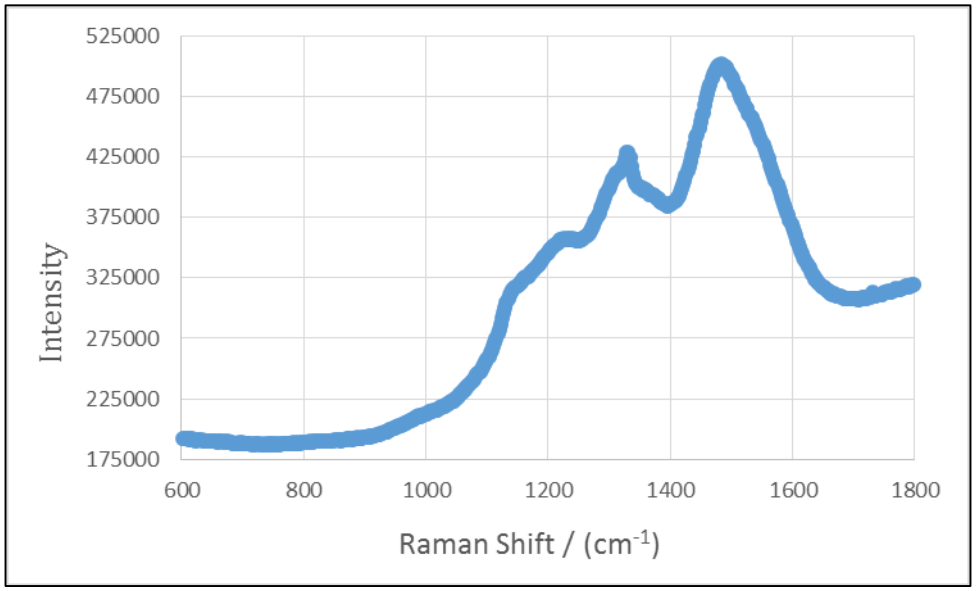

Figure 45: Raman spectra recorded for large silicon needles coated in a NCD film grown for 4 houts after electrospray pretreatment.

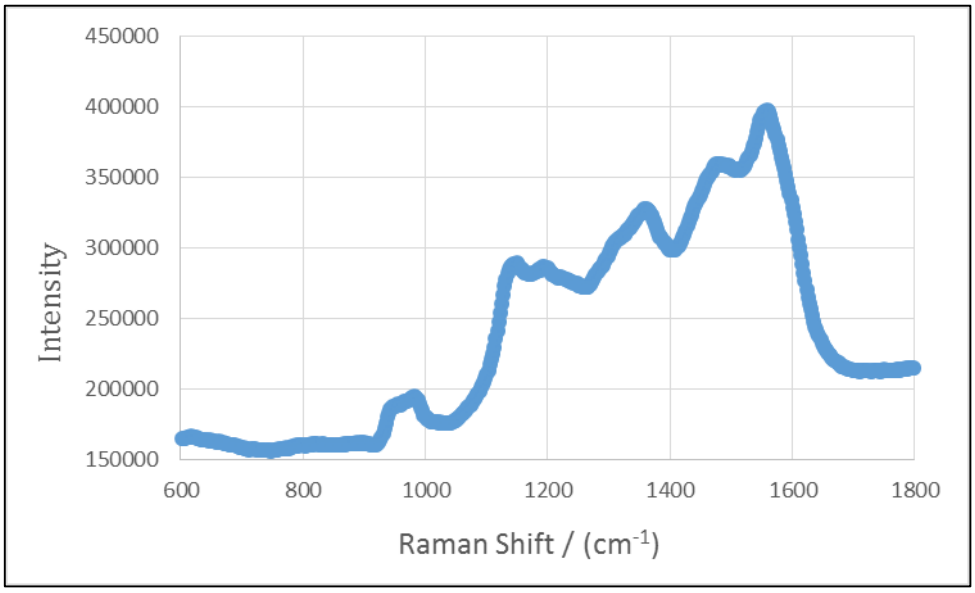

Figure 46: Raman spectra recorded for small silicon needles coated in a MCD film grown for 30 mins after electrospray pretreatment.

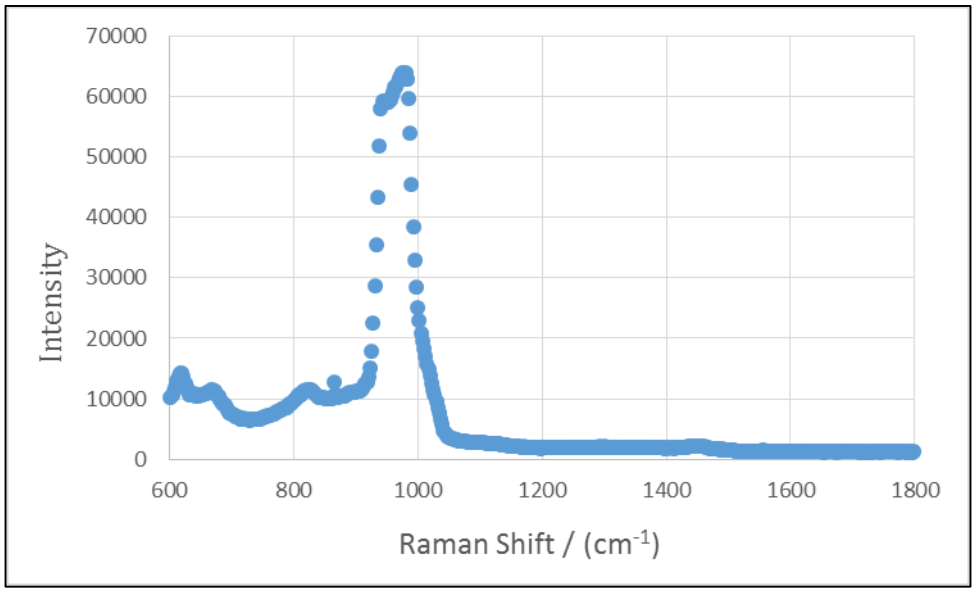

Figure 47: Raman spectra recorded for small silicon needles coated in a MCD film grown for 30 mins.

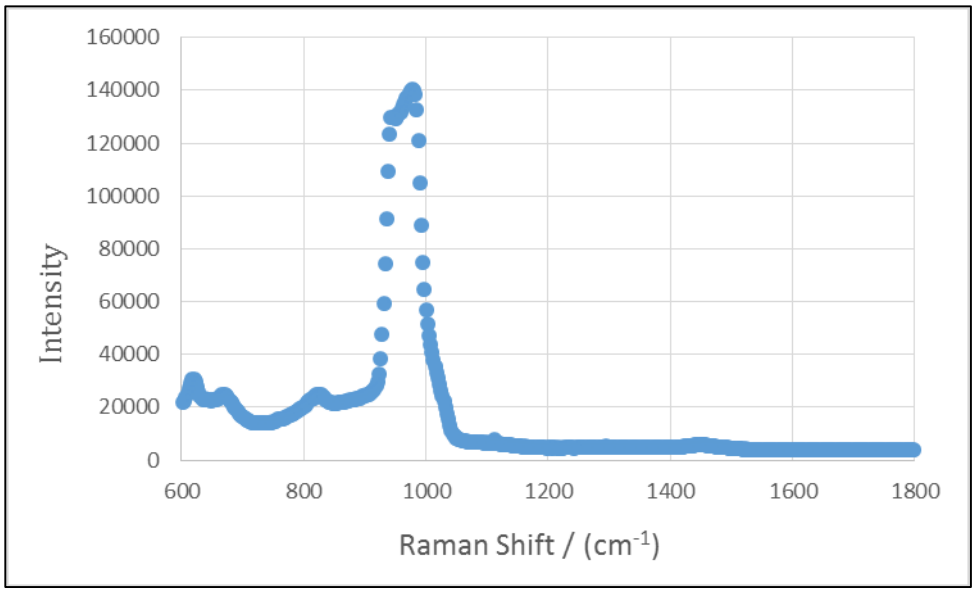

Figure 48: Raman spectra recorded for small silicon needles coated in a MCD film grown for 1 hour.

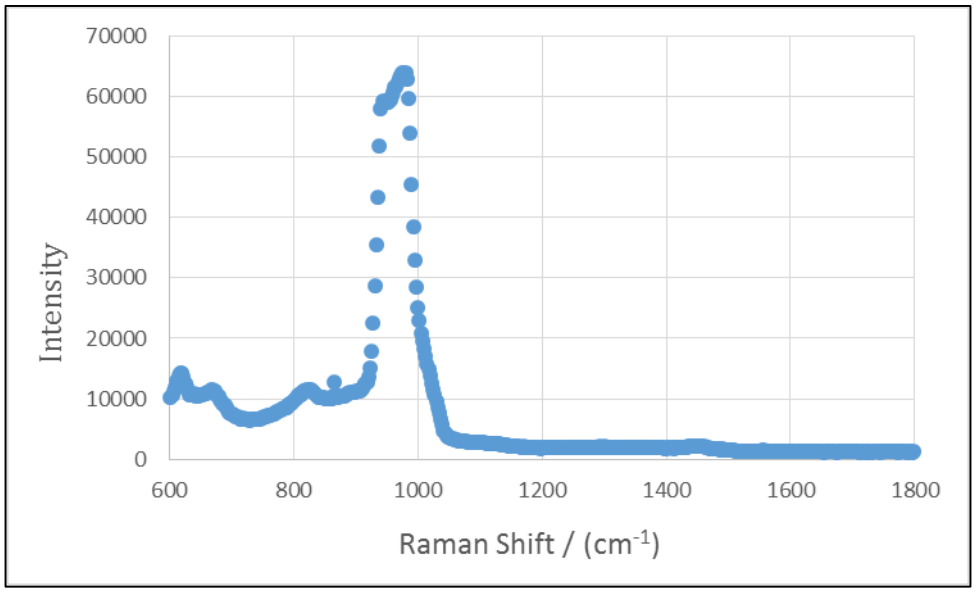

Figure 49: Raman spectra recorded for small silicon needles coated in a MCD film grown for 30 mins.

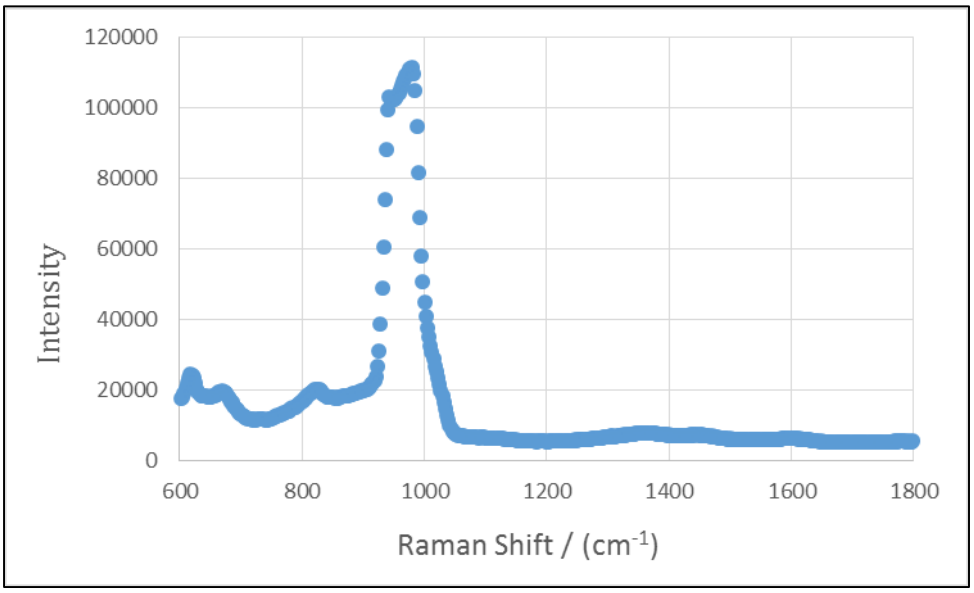

Figure 50: Raman spectra recorded for small silicon needles coated in a MCD film grown for 2 hours.

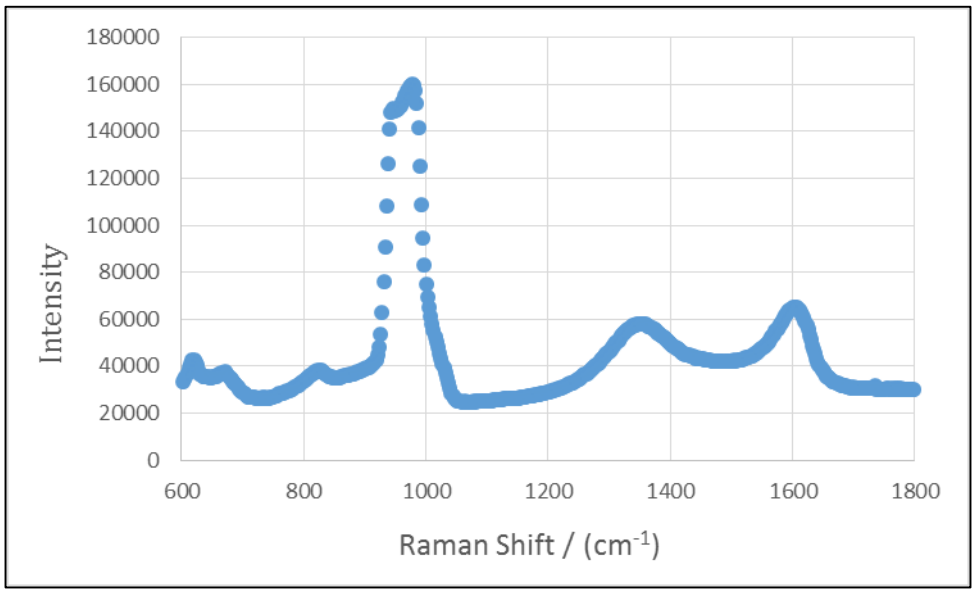

Figure 51: Raman spectra recorded for small silicon needles coated in a NCD film grown for 1 hour.

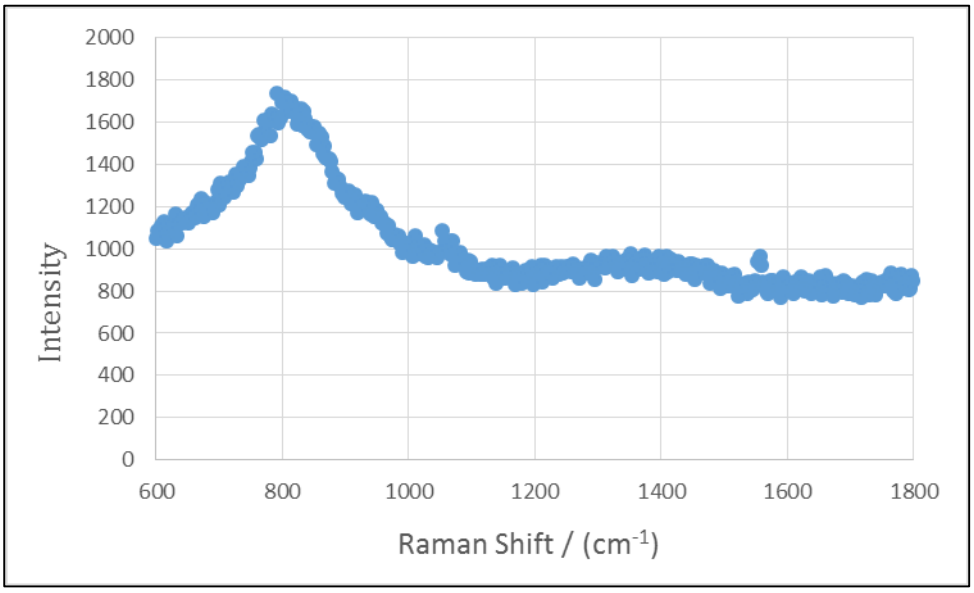

Figure 52: Raman spectra recorded for VACNT teepees coated in a MCD film grown for 20 mins after electrospray pretreatment.

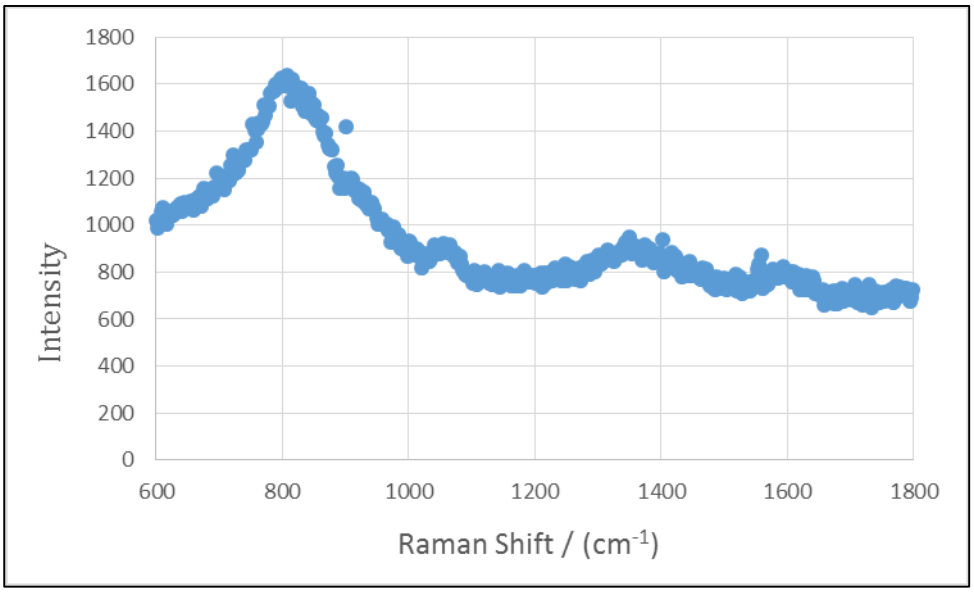

Figure 53: Raman spectra recorded for CNT webs coated in a MCD film grown for 20 mins after electrospray pretreatment.

Cyclic Voltammetry – KNO_3

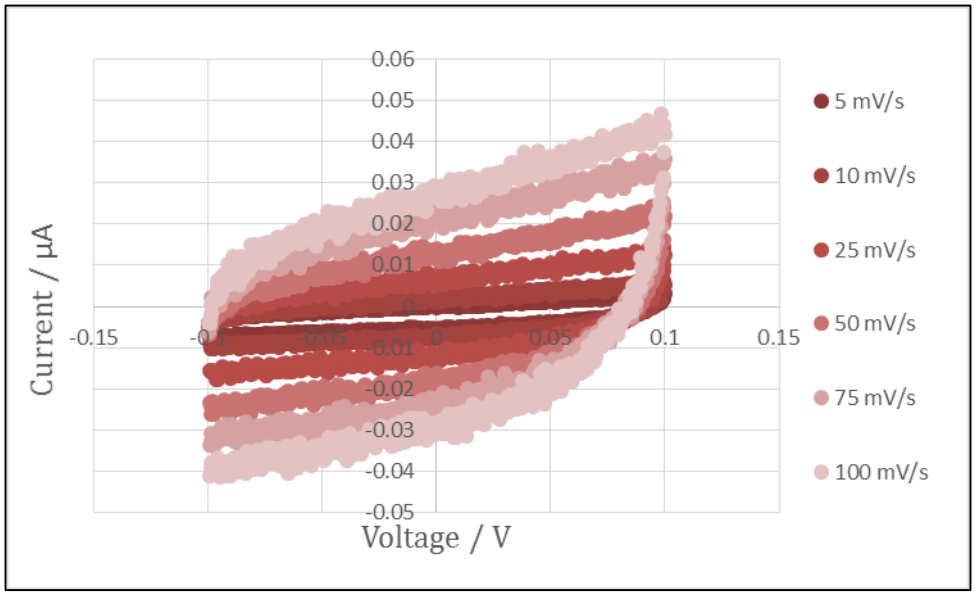

Figure 54: Cyclic Voltammograms (CVs) recorded for flat boron doped diamond sample using a 1 M potassium nitrate solution.

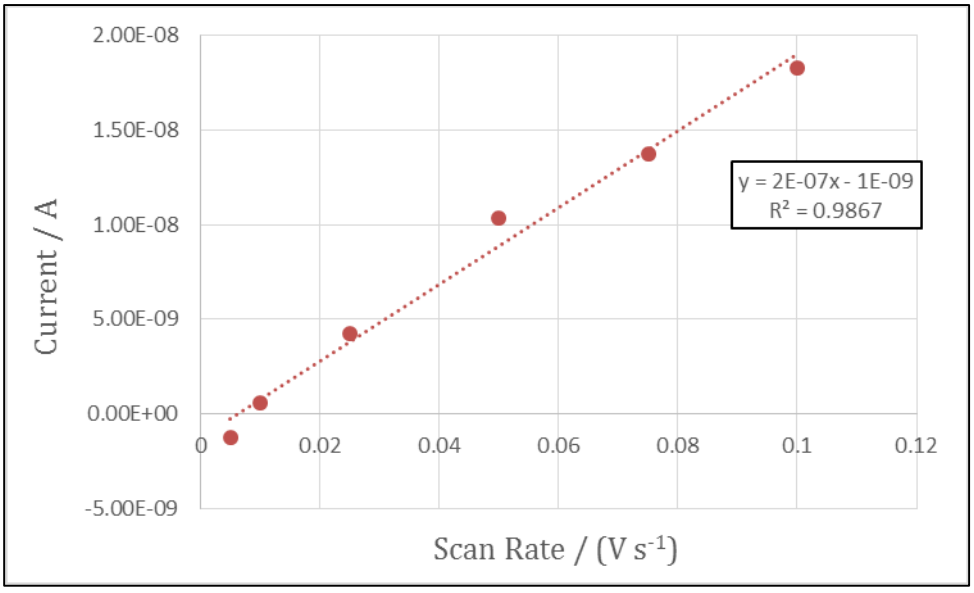

Figure 55: Plot of capacitive current vs scan rate for flat boron doped diamond sample.

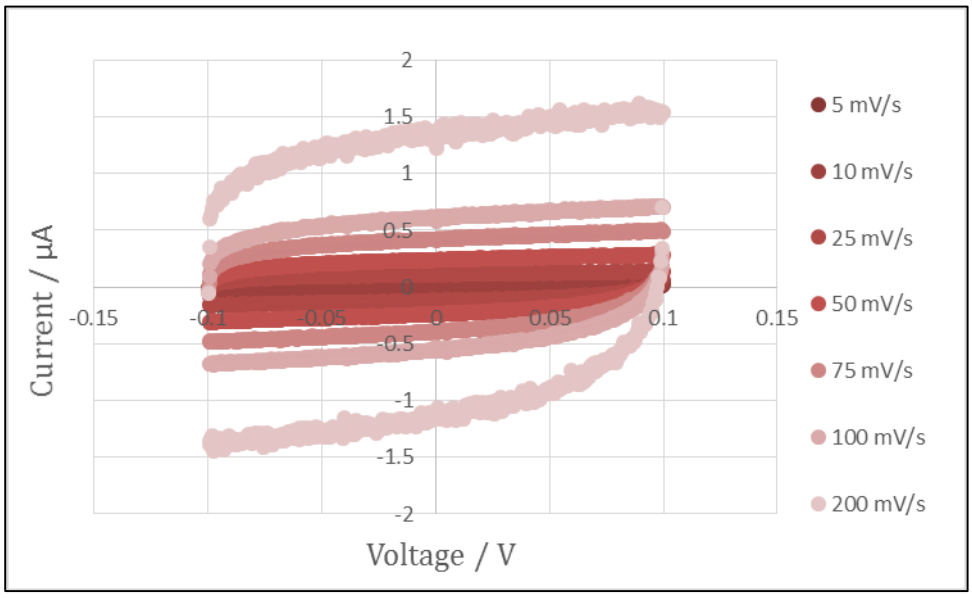

Figure 56: CVs recorded for large black silicon needles coated in a MCD film grown for 20 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

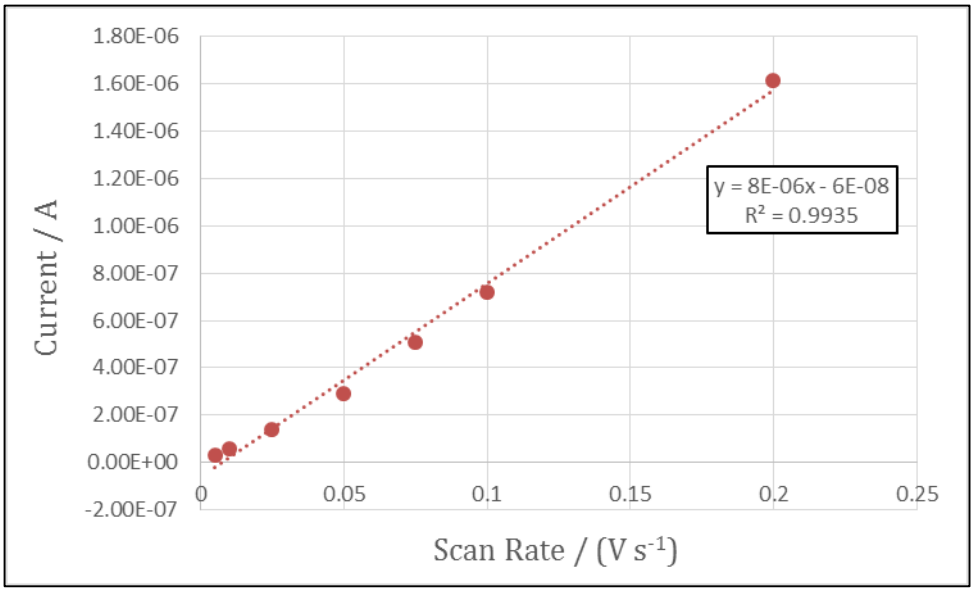

Figure 57: Plot of capacitive current vs scan rate for large black silicon needles coated in a MCD film grown for 20 mins after electrospray pretreatment.

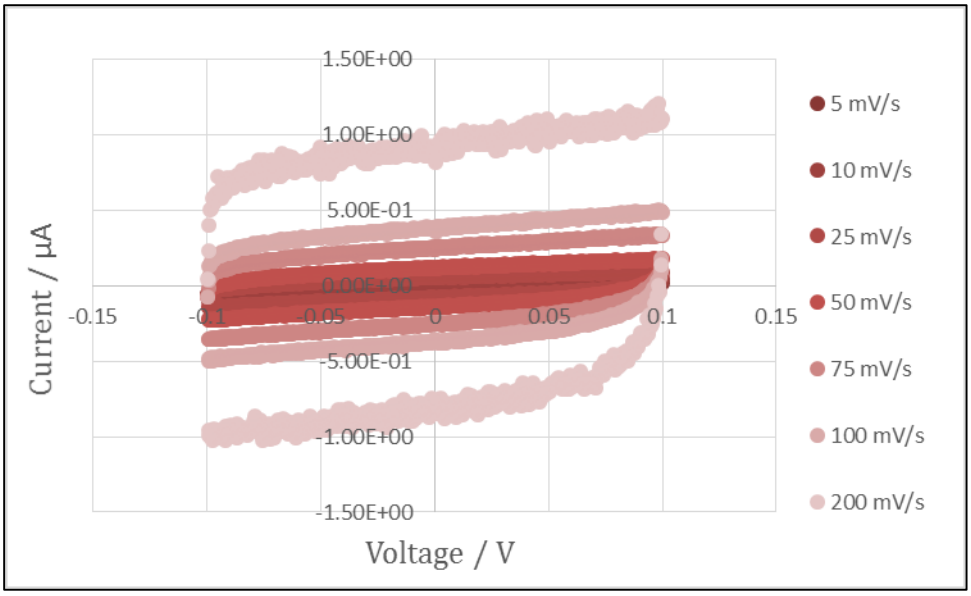

Figure 58: CVs recorded for large black silicon needles coated in a MCD film grown for 45 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

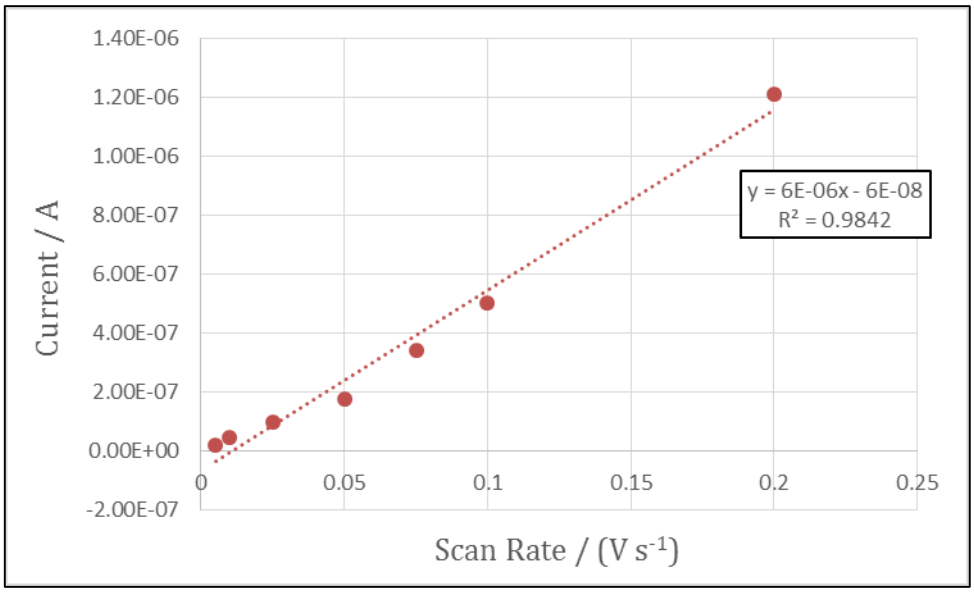

Figure 59: Plot of capacitive current vs scan rate for large black silicon needles coated in a MCD film grown for 45 mins after electrospray pretreatment.

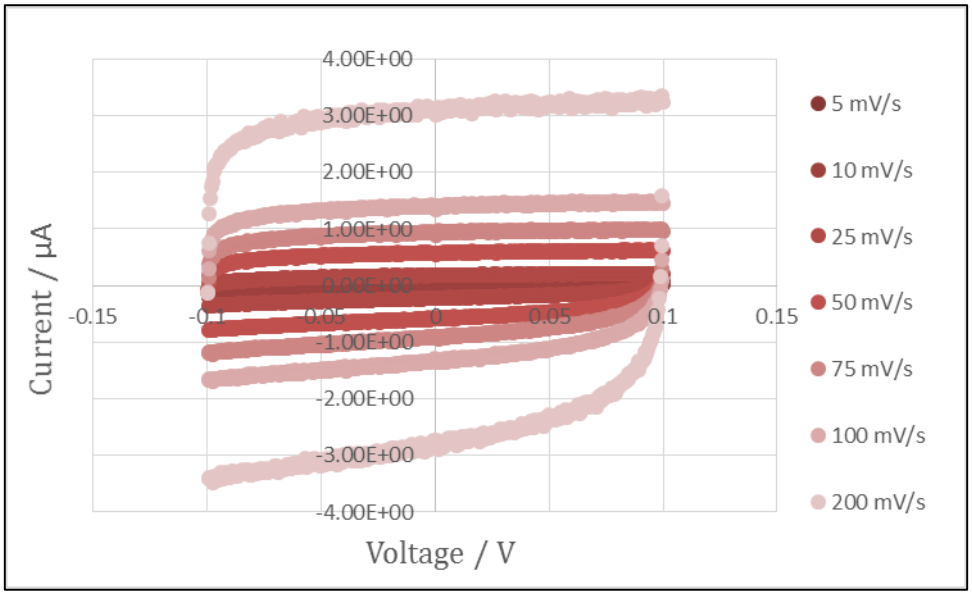

Figure 60: CVs recorded for large black silicon needles coated in a MCD film grown for 2 hours after electrospray pretreatment using a 1 M potassium nitrate solution.

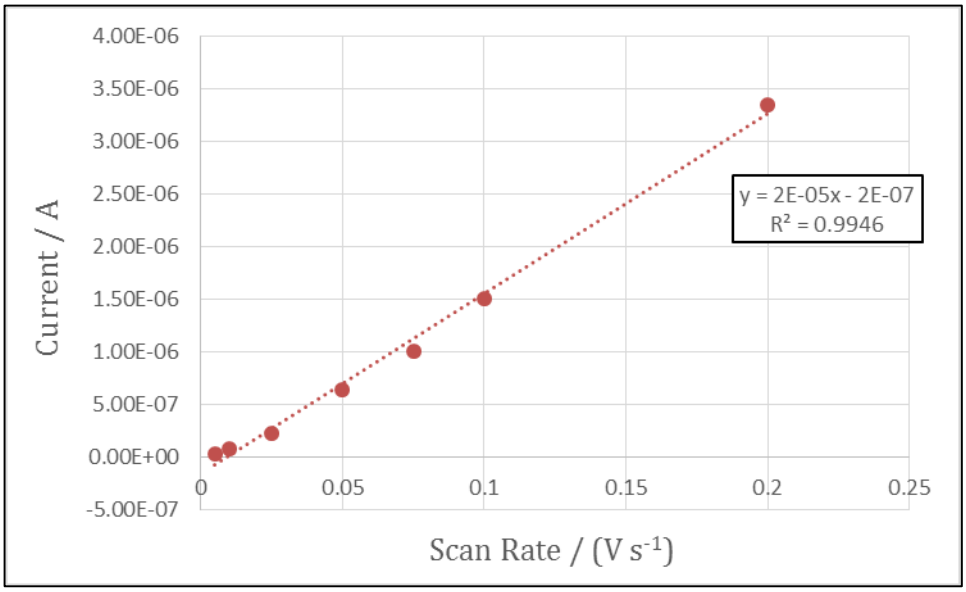

Figure 61: Plot of capacitive current vs scan rate for large black silicon needles coated in a MCD film grown for 2 hours after electrospray pretreatment.

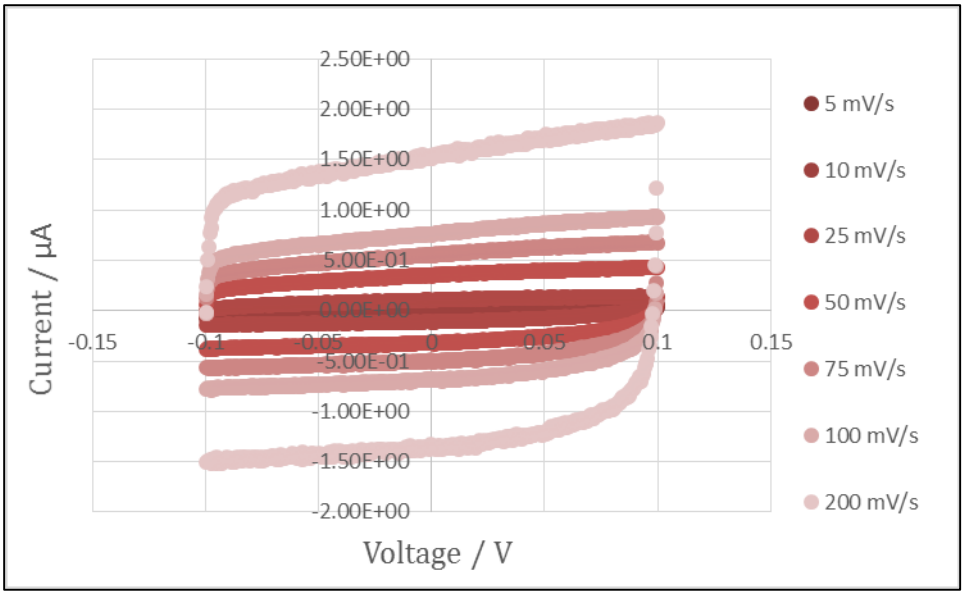

Figure 62: CVs recorded for large black silicon needles coated in a NCD film grown for 20 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

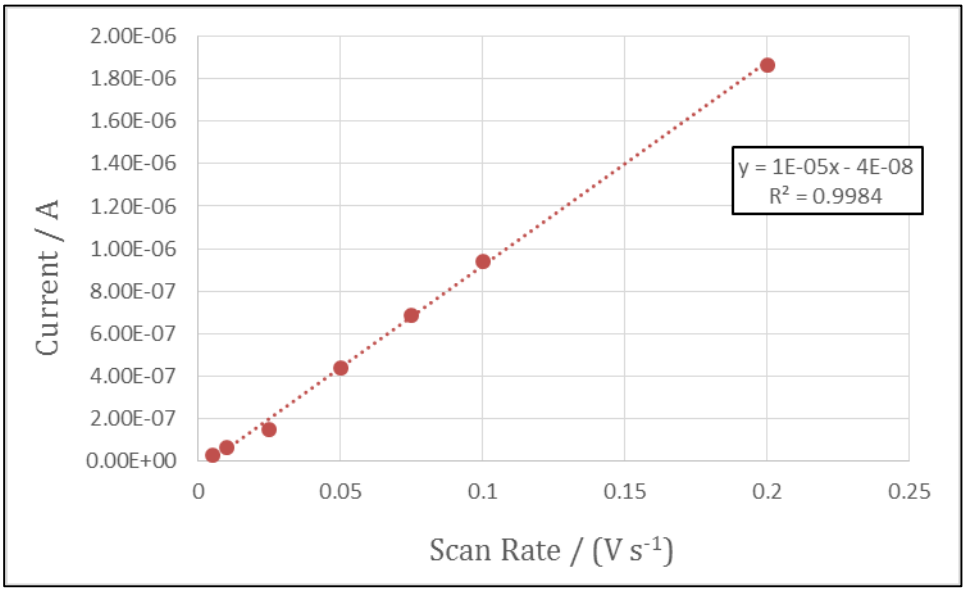

Figure 63: Plot of capacitive current vs scan rate for large black silicon needles coated in a NCD film grown for 20 mins after electrospray pretreatment.

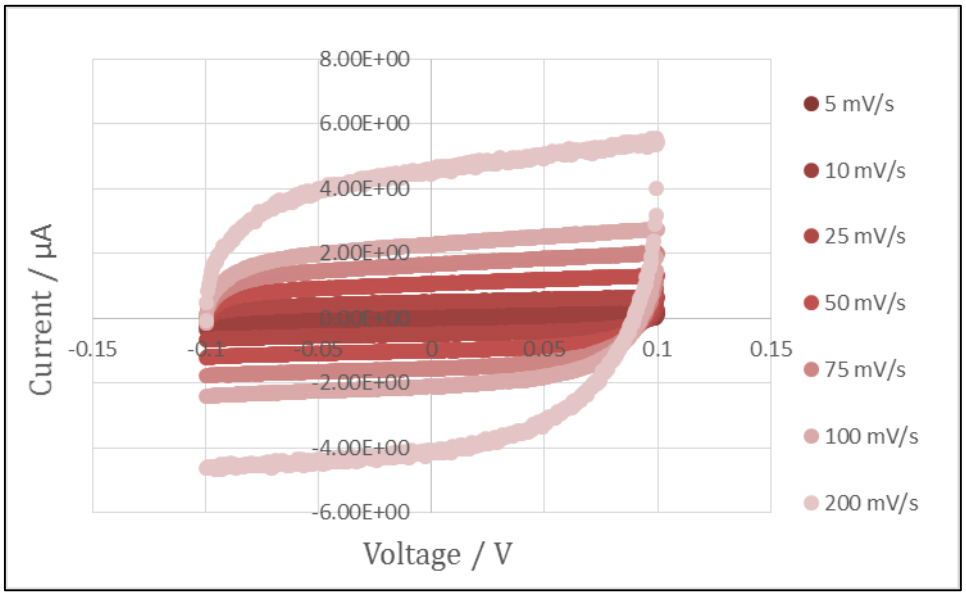

Figure 64: CVs recorded for large black silicon needles coated in a NCD film grown for 40 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

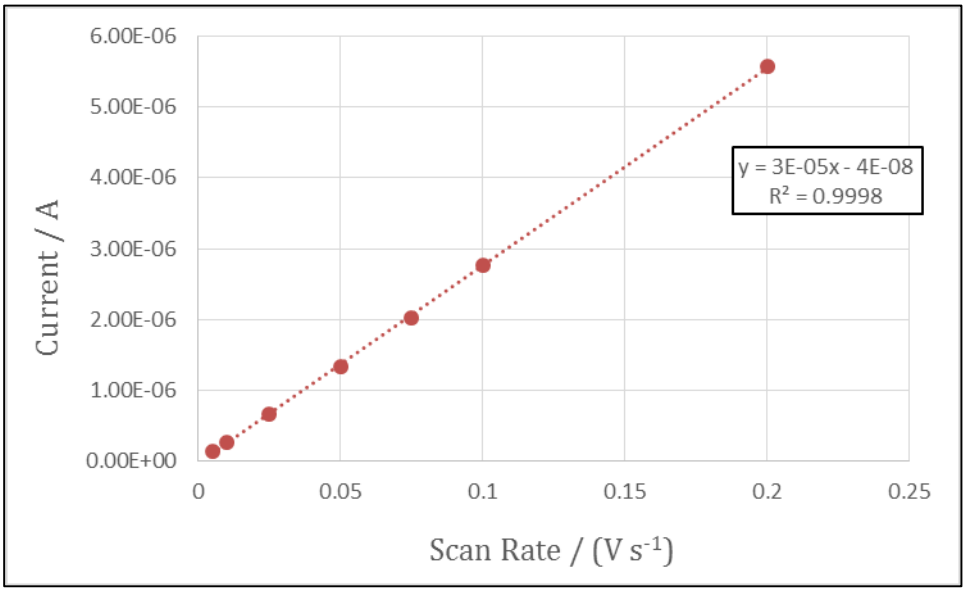

Figure 65: Plot of capacitive current vs scan rate for large black silicon needles coated in a NCD film grown for 40 mins after electrospray pretreatment.

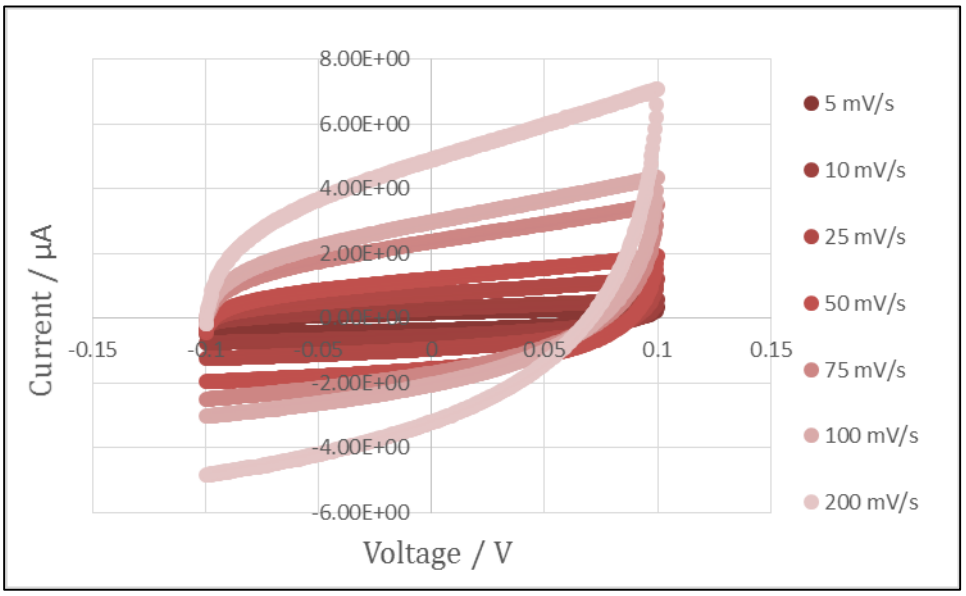

Figure 66: CVs recorded for large black silicon needles coated in a NCD film grown for 1 hour 20 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

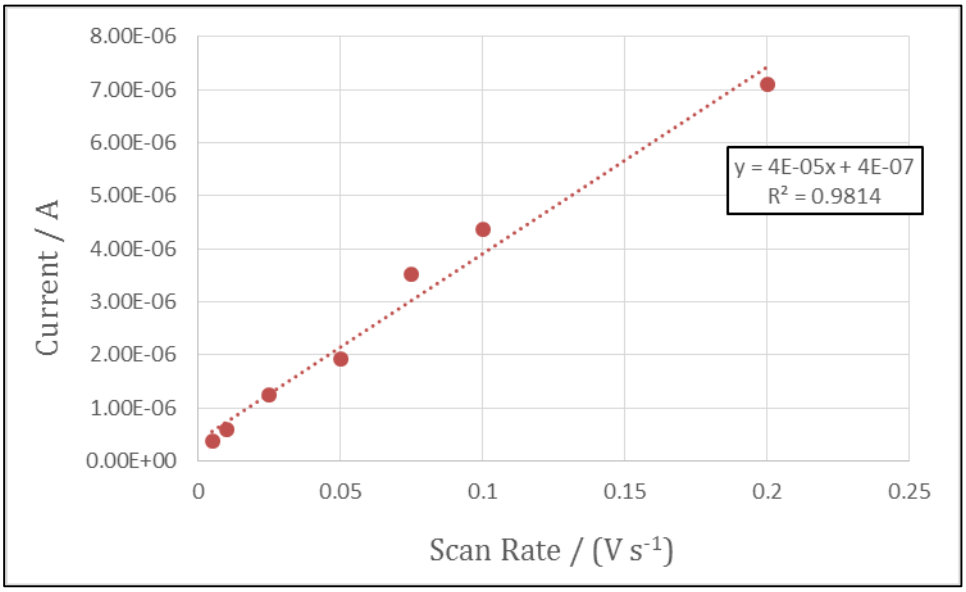

Figure 67: Plot of capacitive current vs scan rate for large black silicon needles coated in a NCD film grown for 1 hour 20 mins after electrospray pretreatment.

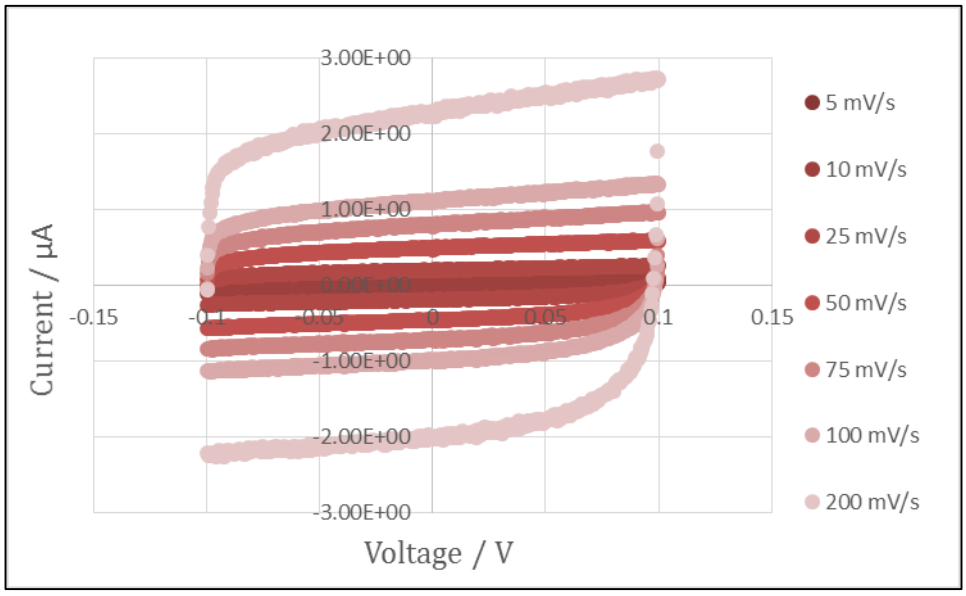

Figure 68: CVs recorded for large black silicon needles coated in a NCD film grown for 2 hours (Overgrown silicon needles) after electrospray pretreatment using a 1 M potassium nitrate solution.

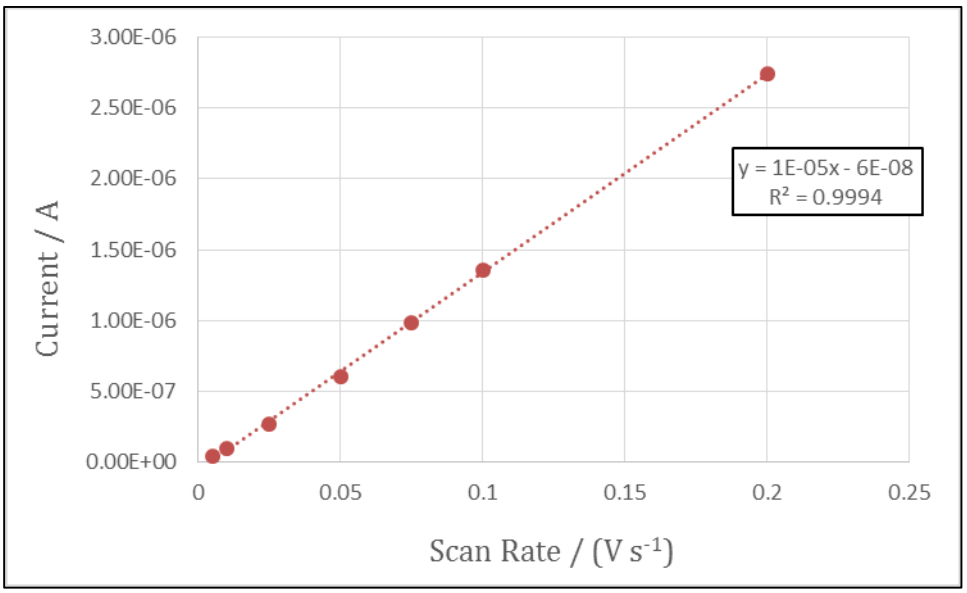

Figure 69: Plot of capacitive current vs scan rate for large black silicon needles coated in a NCD film grown for 2 hours (Overgrown silicon needles) after electrospray pretreatment.

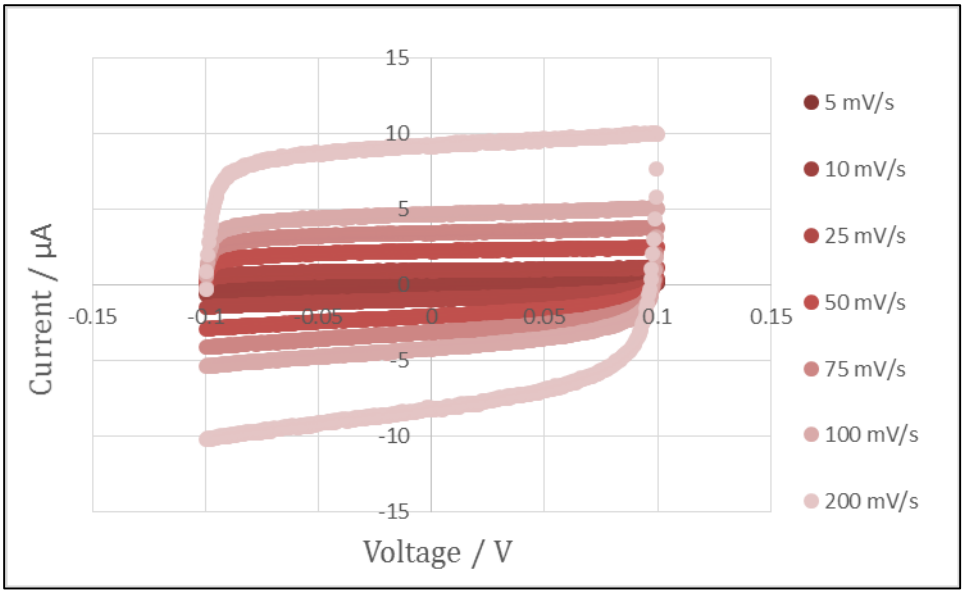

Figure 70: CVs recorded for large black silicon needles coated in a NCD film grown for 3 hours (Overgrown silicon needles) after electrospray pretreatment using a 1 M potassium nitrate solution.

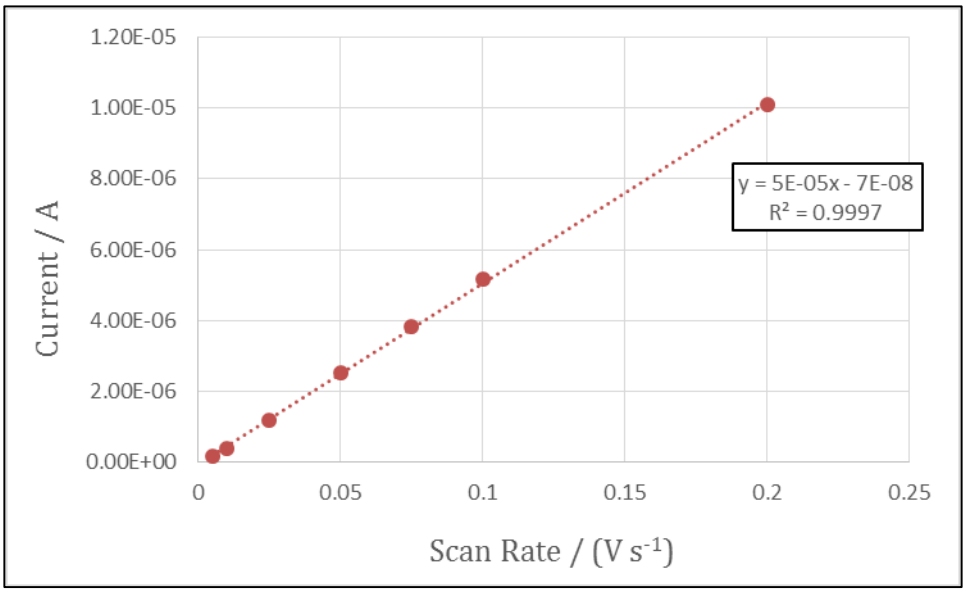

Figure 71: Plot of capacitive current vs scan rate for large black silicon needles coated in a NCD film grown for 3 hours (Overgrown silicon needles) after electrospray pretreatment.

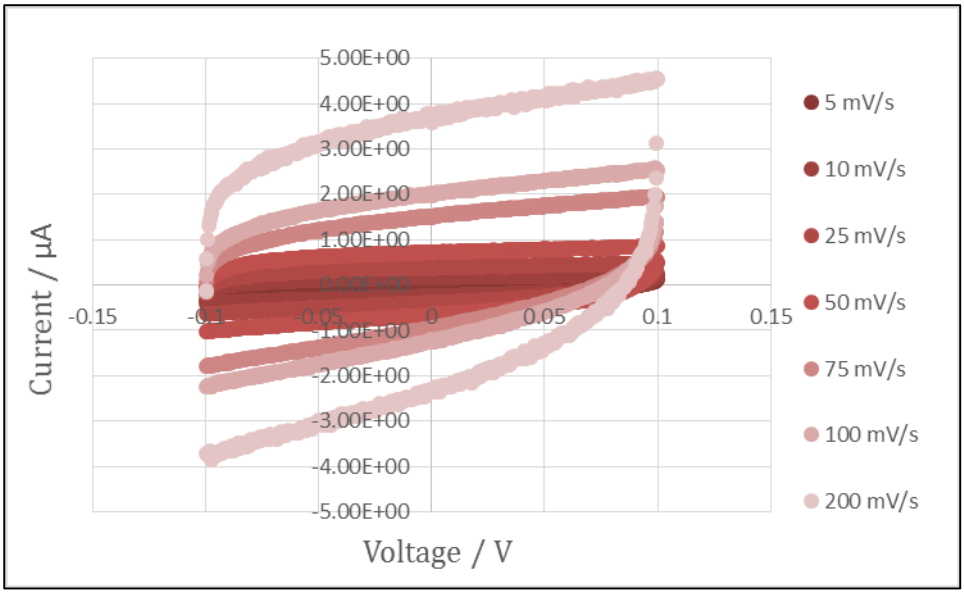

Figure 72: CVs recorded for large black silicon needles coated in a NCD film grown for 4 hours (Overgrown silicon needles) after electrospray pretreatment using a 1 M potassium nitrate solution.

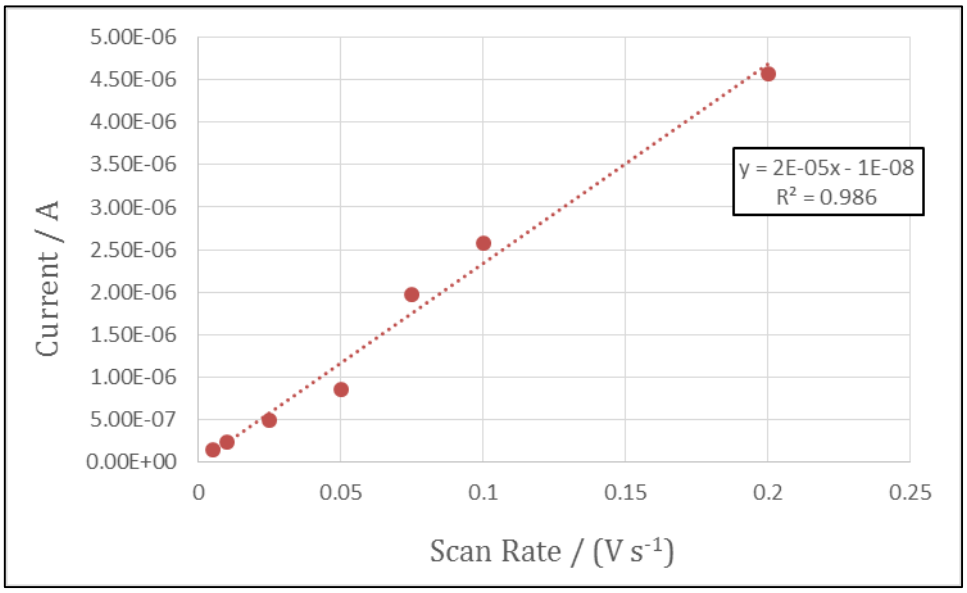

Figure 73: Plot of capacitive current vs scan rate for large black silicon needles coated in a NCD film grown for 4 hours (Overgrown silicon needles) after electrospray pretreatment.

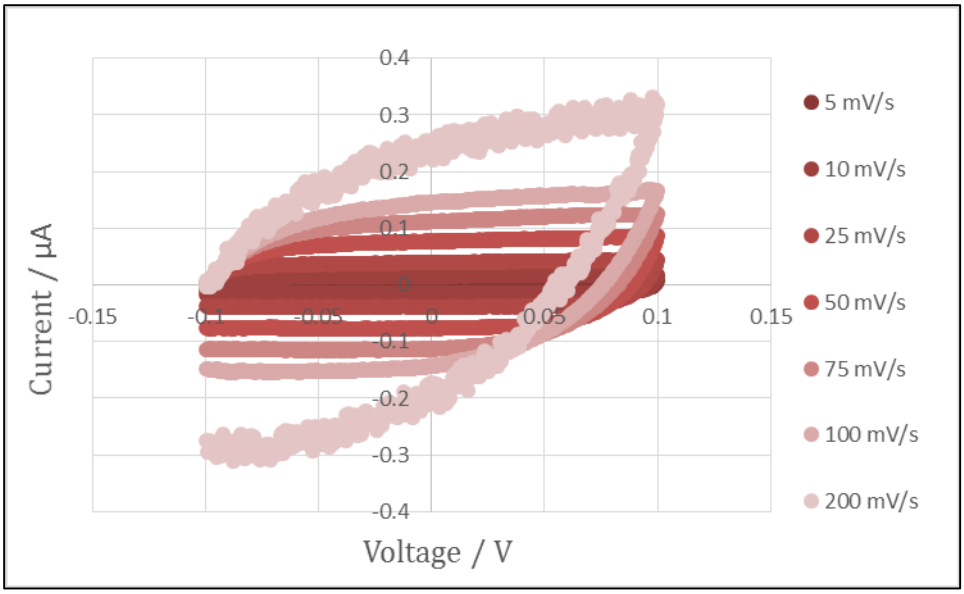

Figure 74: CVs recorded for small black silicon needles coated in a MCD film grown for 45 mins using a 1 M potassium nitrate solution.

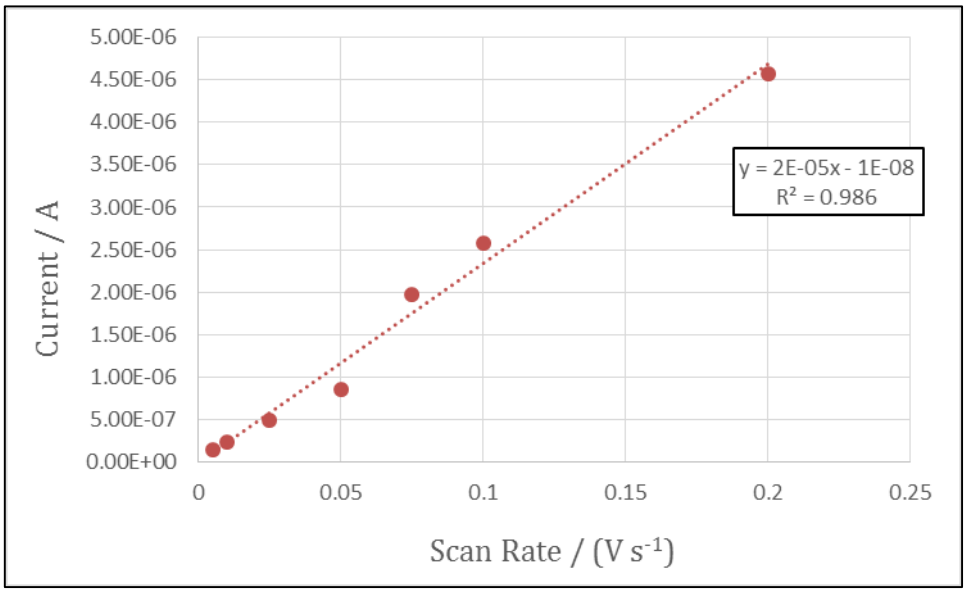

Figure 75: Plot of capacitive current vs scan rate for small black silicon needles coated in a MCD film grown for 45 mins.

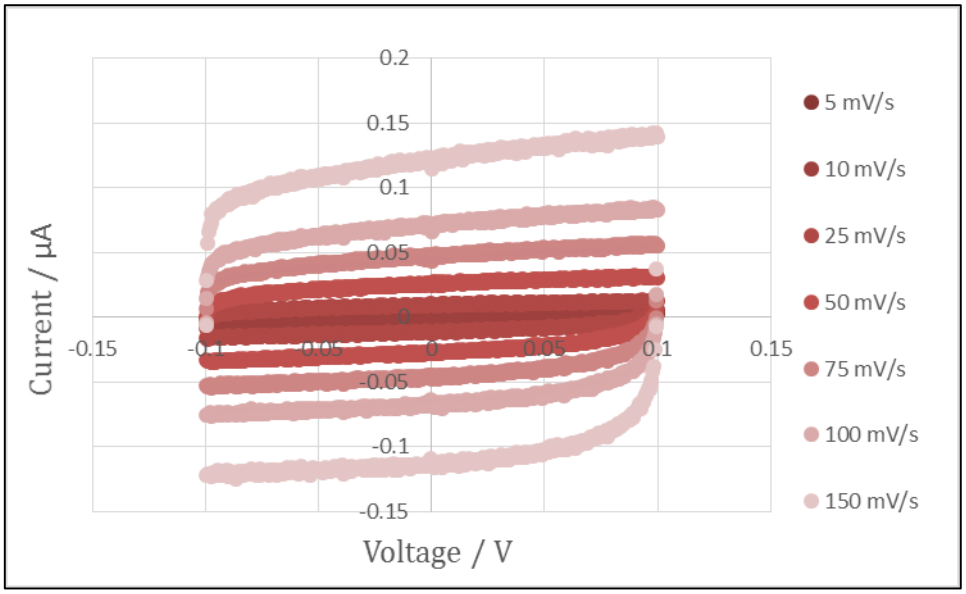

Figure 76: CVs recorded for small black silicon needles coated in a MCD film grown for 2 hours using a 1 M potassium nitrate solution.

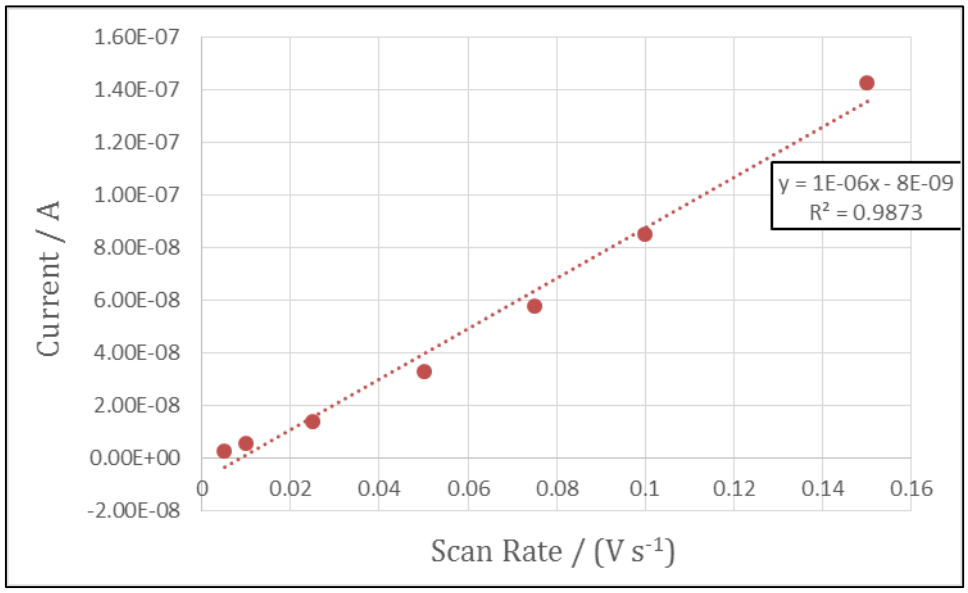

Figure 77: Plot of capacitive current vs scan rate for small black silicon needles coated in a MCD film grown for 2 hours.

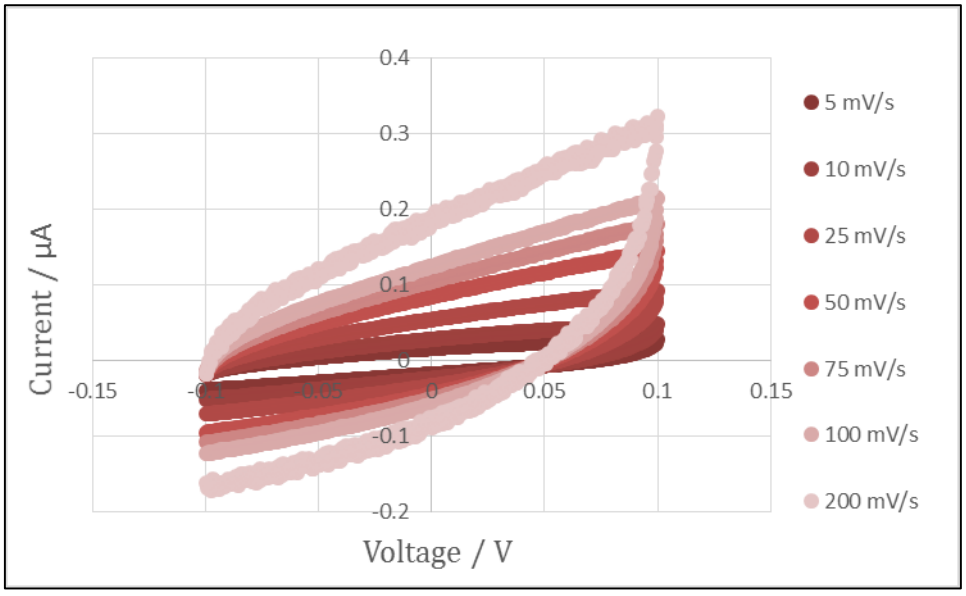

Figure 78: CVs recorded for small black silicon needles coated in a NCD film grown for 1 hour using a 1 M potassium nitrate solution.

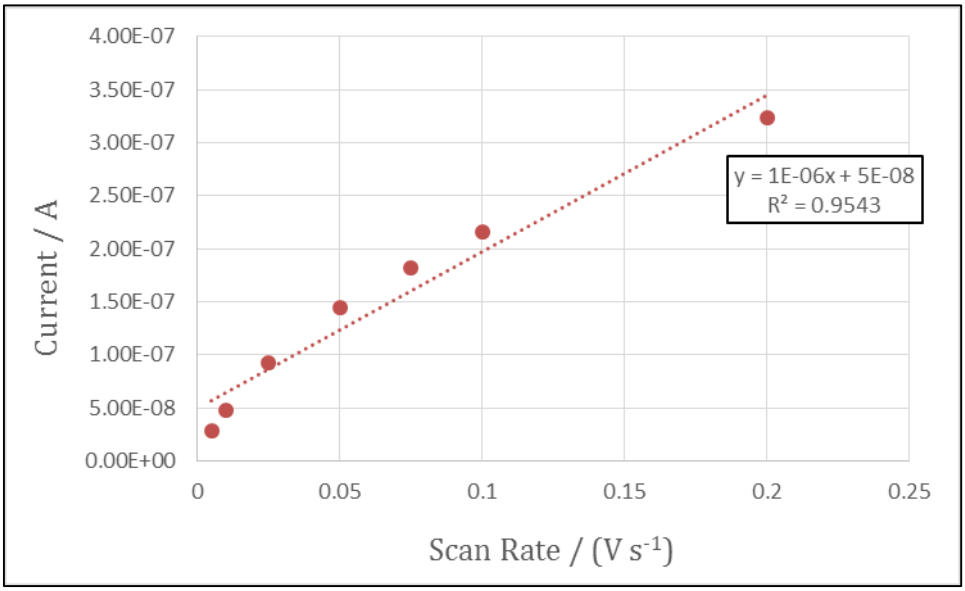

Figure 79: Plot of capacitive current vs scan rate for small black silicon needles coated in a NCD film grown for 1 hour.

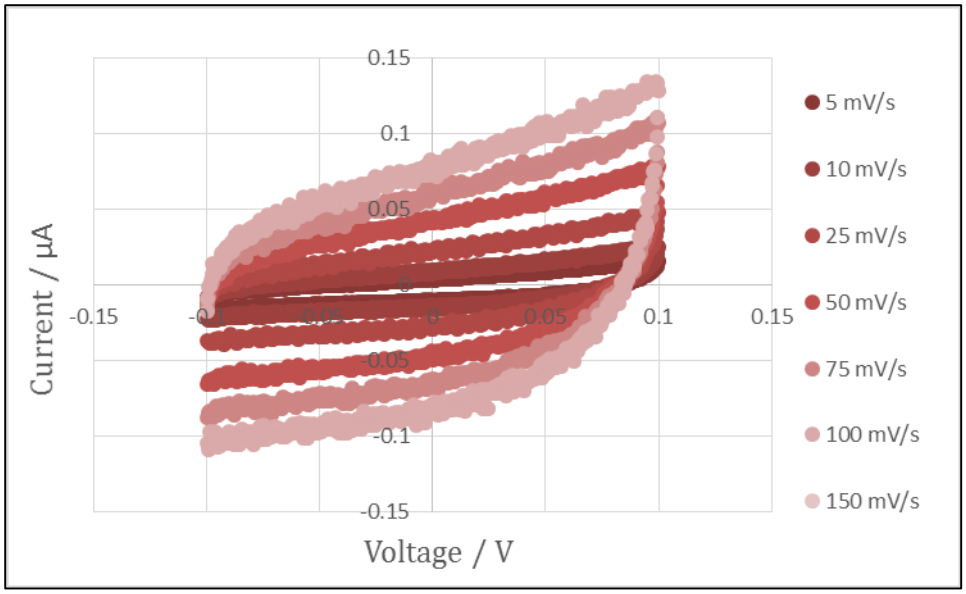

Figure 80: CVs recorded for VACNT teepees coated in a MCD film grown for 45 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

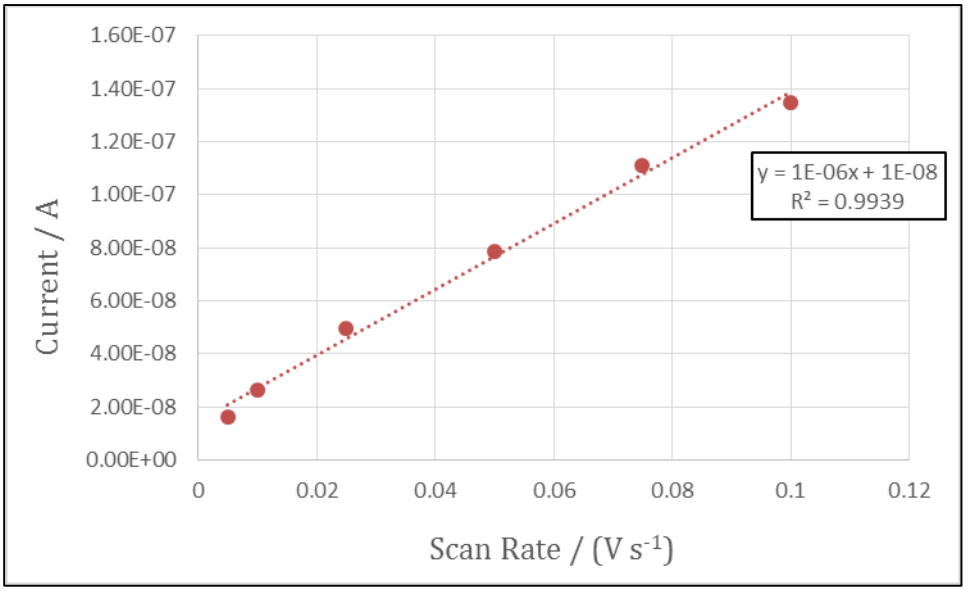

Figure 81: Plot of capacitive current vs scan rate for VACNT teepees coated in a MCD film grown for 45 mins after electrospray pretreatment.

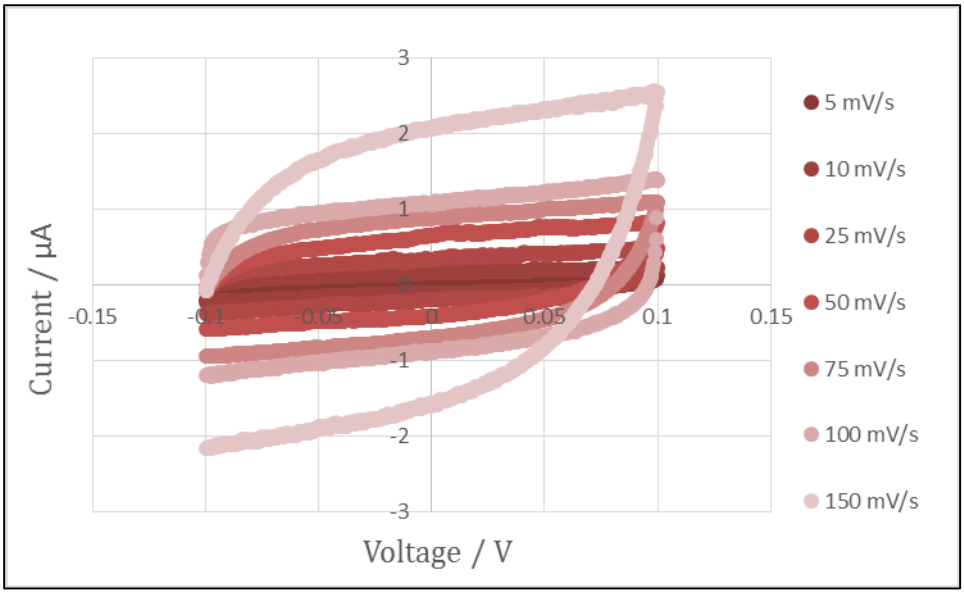

Figure 82: CVs recorded for CNT webs coated in a MCD film grown for 20 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

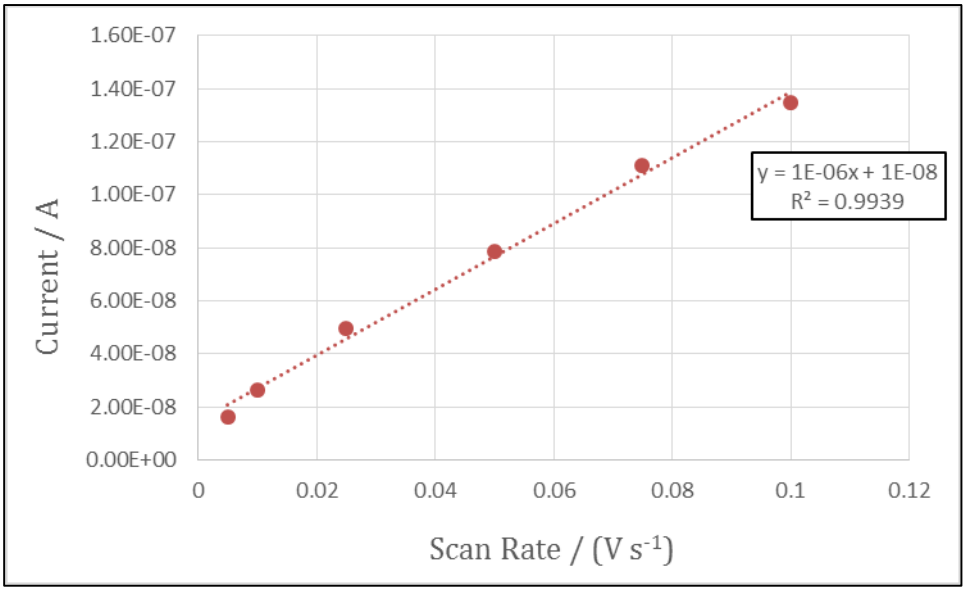

Figure 83: Plot of capacitive current vs scan rate for CNT webs coated in a MCD film grown for 20 mins after electrospray pretreatment.

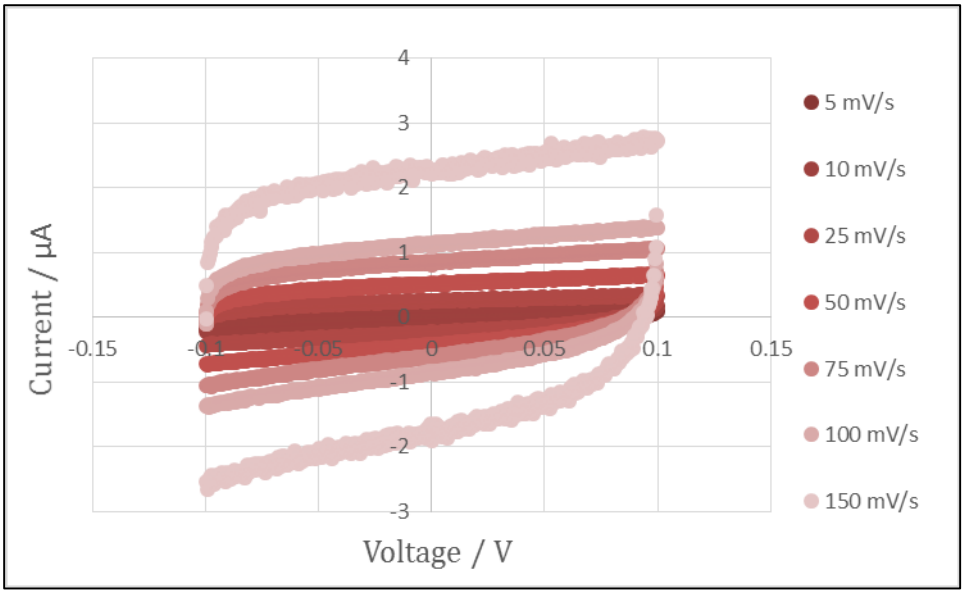

Figure 84: CVs recorded for CNT webs coated in a MCD film grown for 30 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

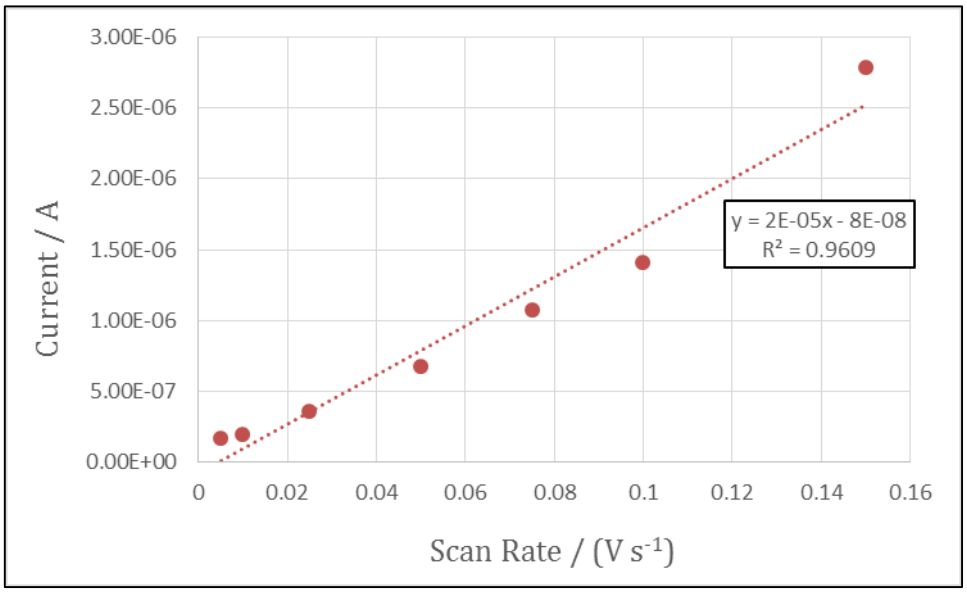

Figure 85: Plot of capacitive current vs scan rate for CNT webs coated in a MCD film grown for 30 mins after electrospray pretreatment.

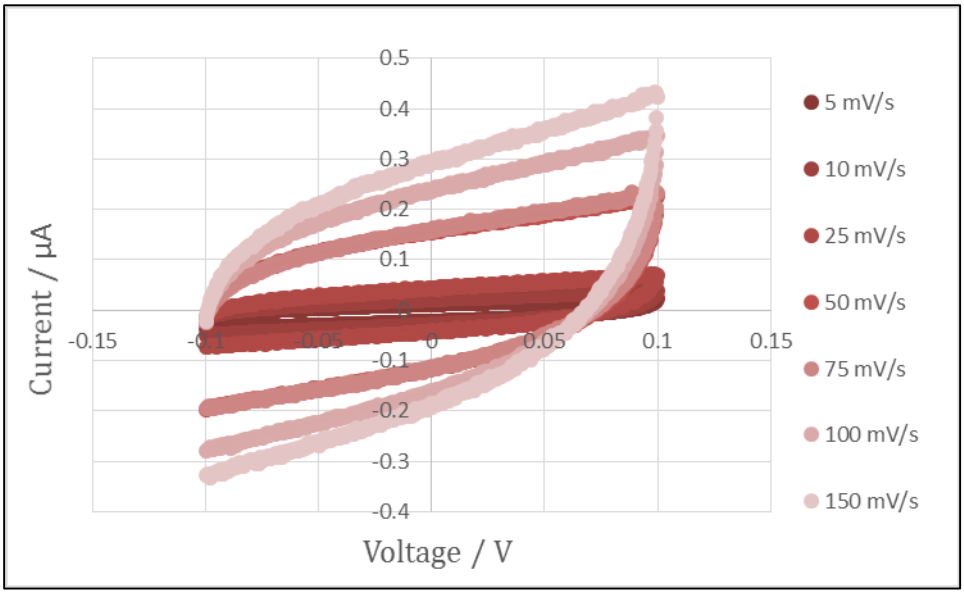

Figure 86: CVs recorded for CNT webs coated in a NCD film grown for 45 mins after electrospray pretreatment using a 1 M potassium nitrate solution.

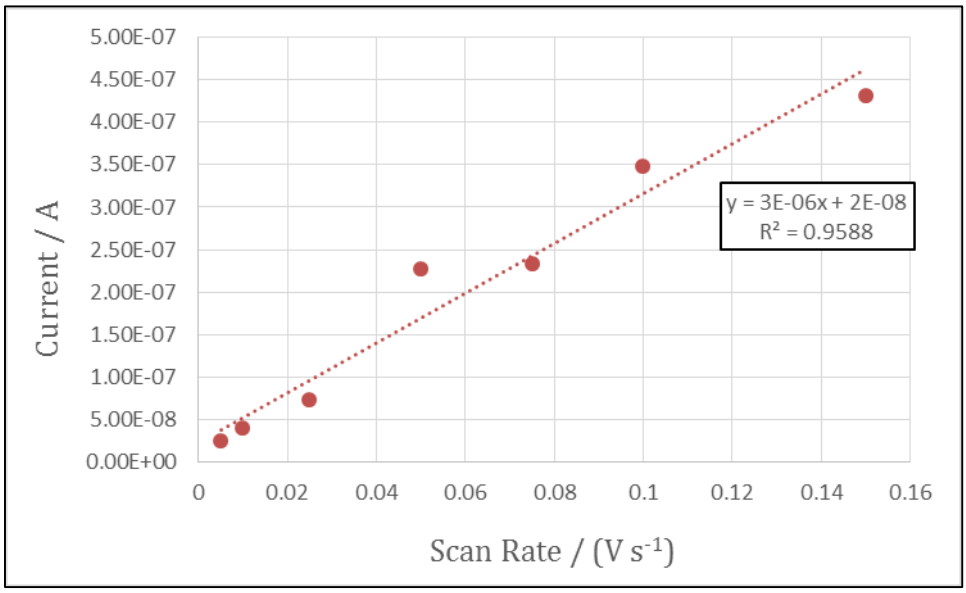

Figure 87: Plot of capacitive current vs scan rate for CNT webs coated in a NCD film grown for 45 mins after electrospray pretreatment.

Cyclic Voltammetry – $K_3[Fe(CN)_6]$

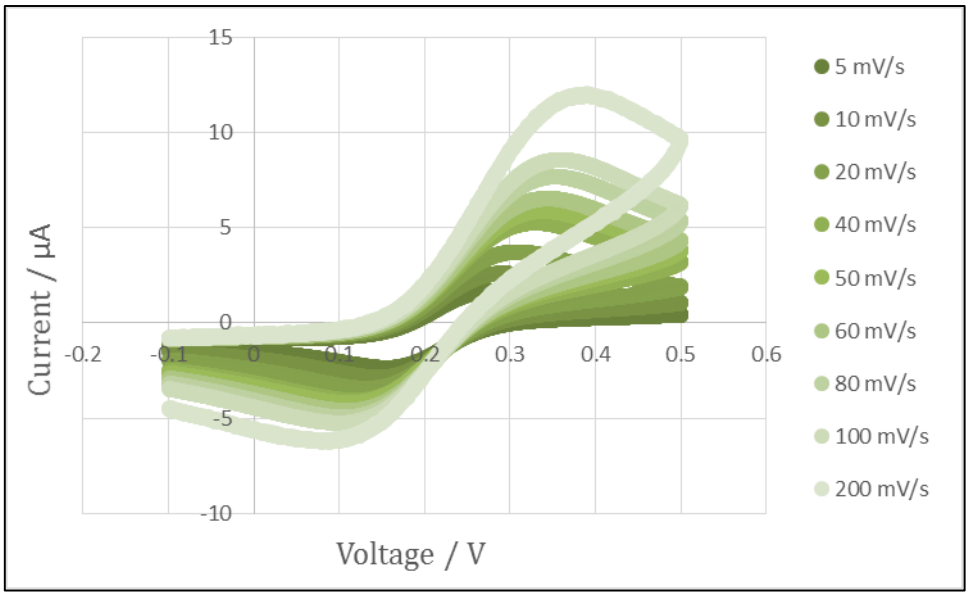

Figure 88: CVs recorded for flat diamond sample using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

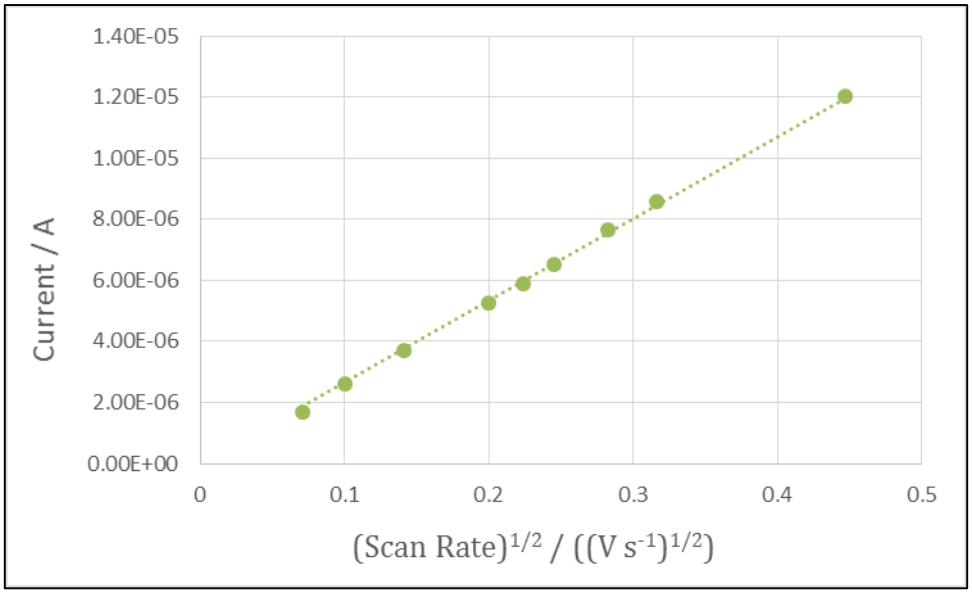

Figure 89: Plot of peak current vs square root of scan rate for flat diamond sample using 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution CVs.

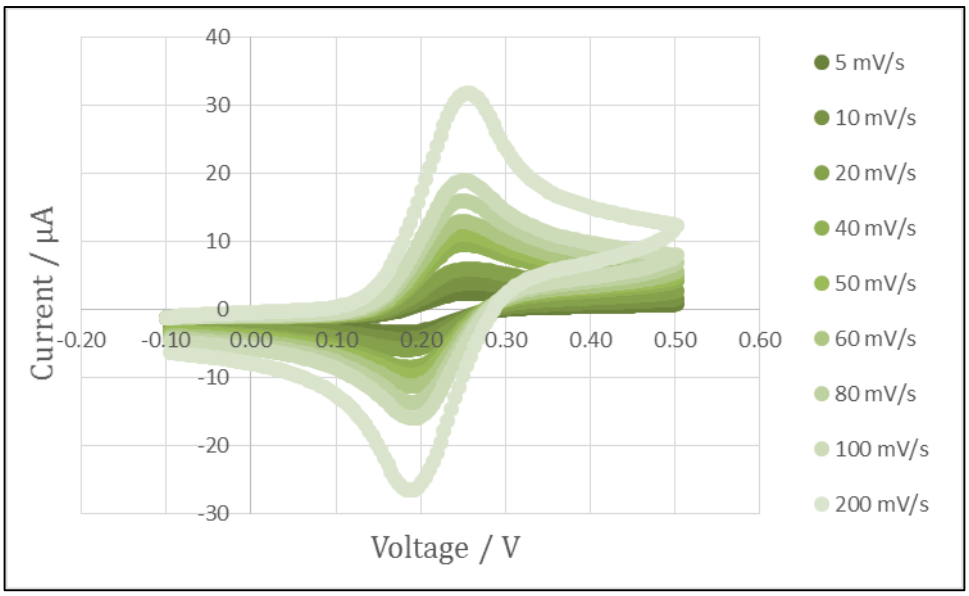

Figure 90: CVs recorded for large black silicon needles coated in a MCD film grown for 20 mins after electrospray pretreatment using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

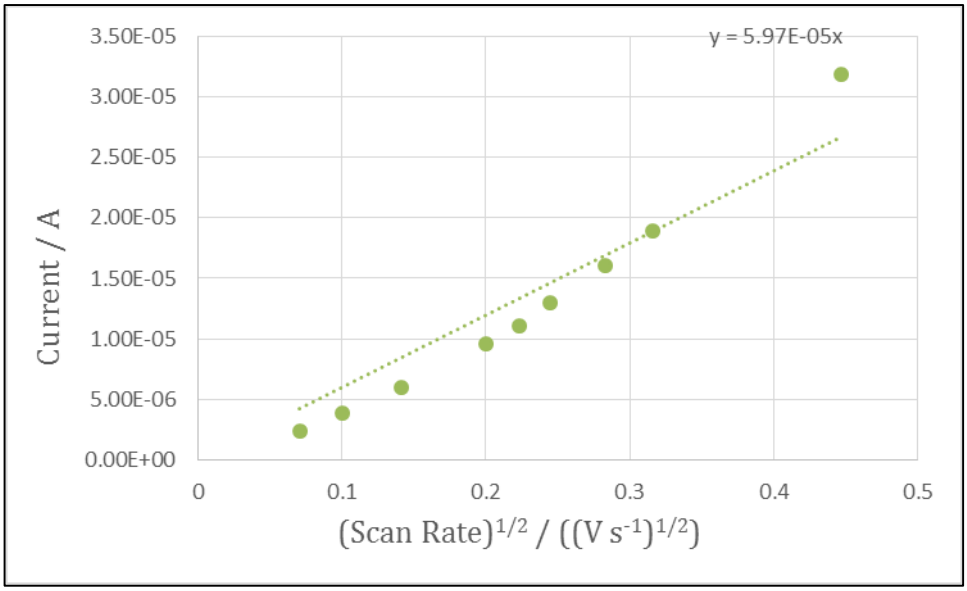

Figure 91: Plot of peak current vs square root of the scan rate for large black silicon needles coated in a MCD film grown for 20 mins after electrospray pretreatment using 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

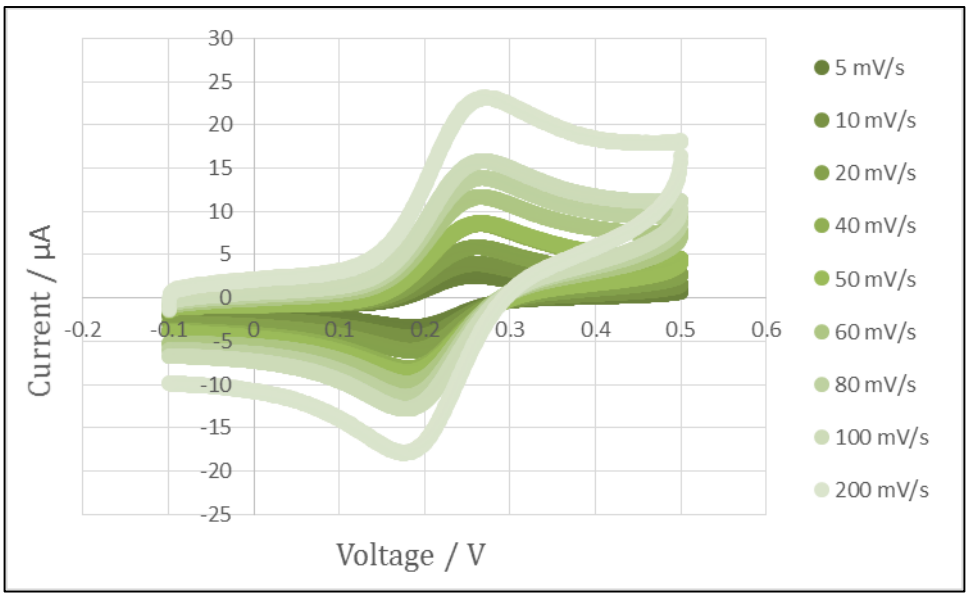

Figure 92: CVs recorded for large black silicon needles coated in a NCD film grown for 3 hours after electrospray pretreatment (overgrown needles) using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

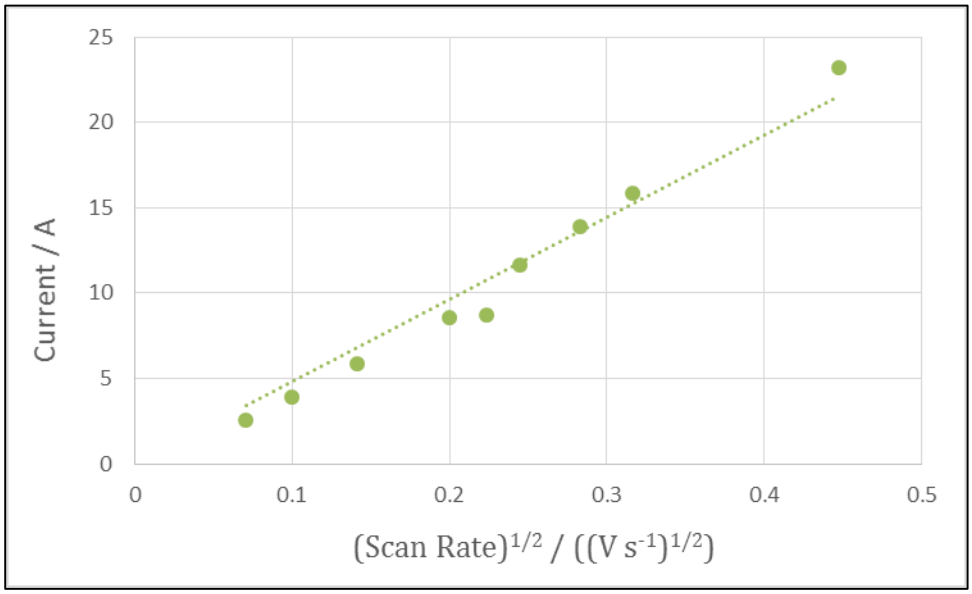

Figure 93: Plot of peak current vs square root of the scan rate for large black silicon needles coated in a NCD film grown for 3 hours after electrospray pretreatment (overgrown needles) using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution

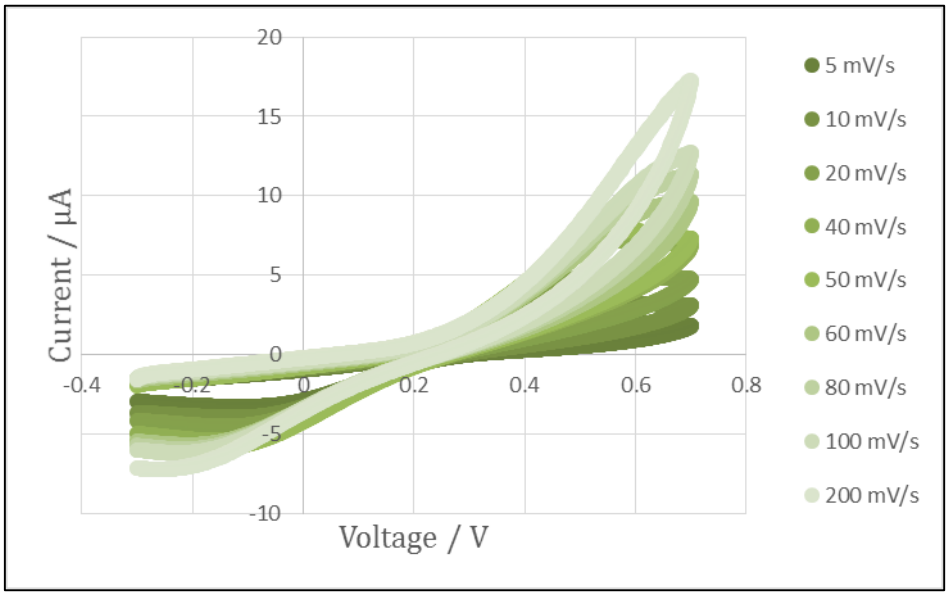

Figure 94: CVs recorded for small black silicon needles coated in a MCD film grown for 2 hours using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

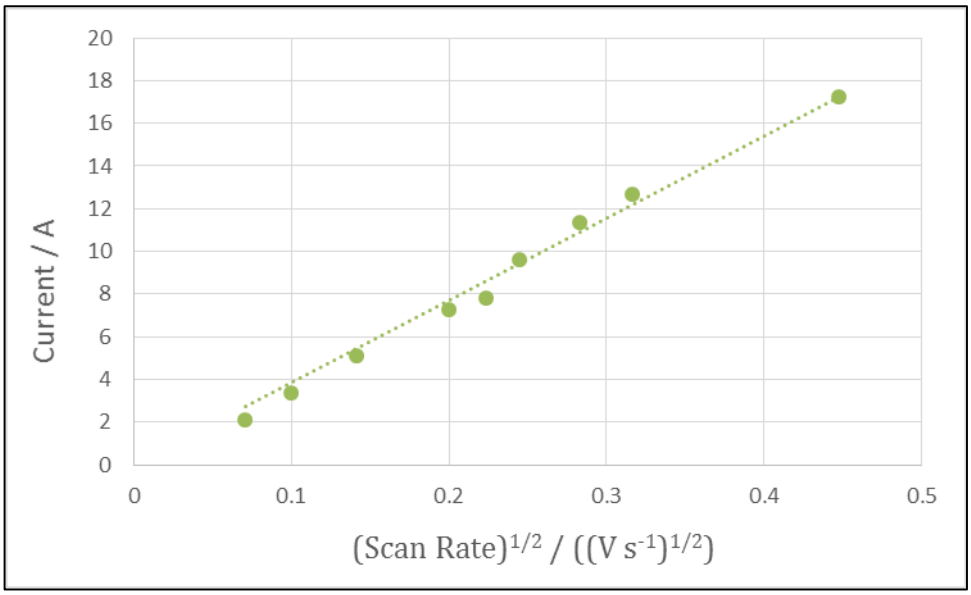

Figure 95: Plot of peak current vs square root of the scan rate for small black silicon needles coated in a MCD film grown for 2 hours using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

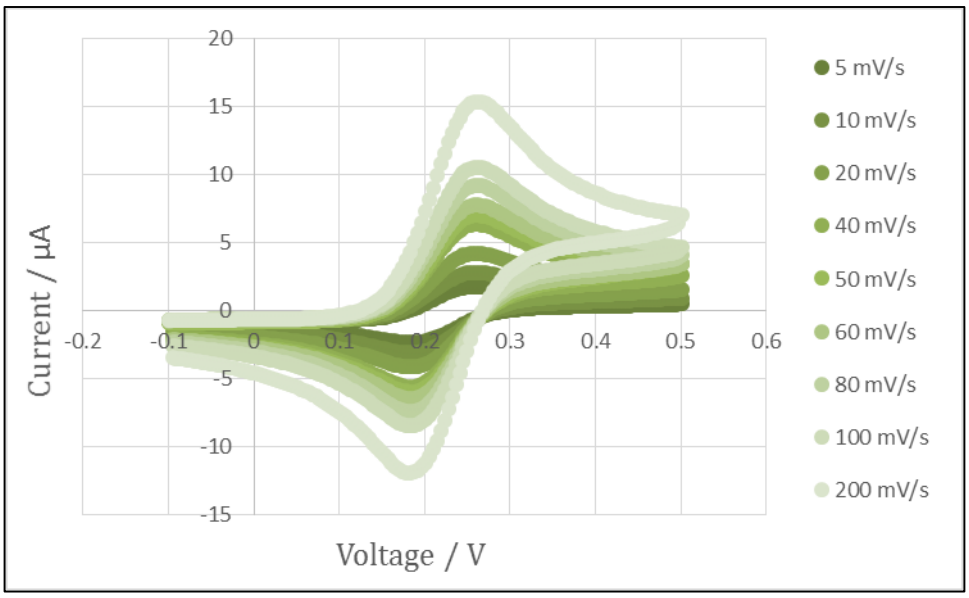

Figure 96: CVs recorded for VACNT teepees in a MCD film grown for 45 mins after electrospray pretreatment using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

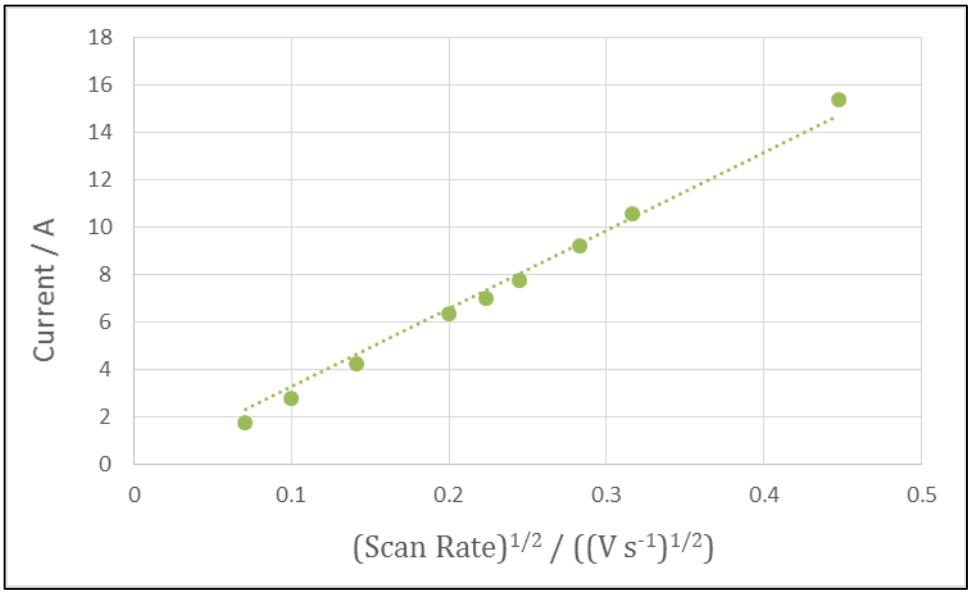

Figure 97: Plot of peak current vs square root of the scan rate VACNT teepees in a MCD film grown for 45 mins after electrospray pretreatment using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

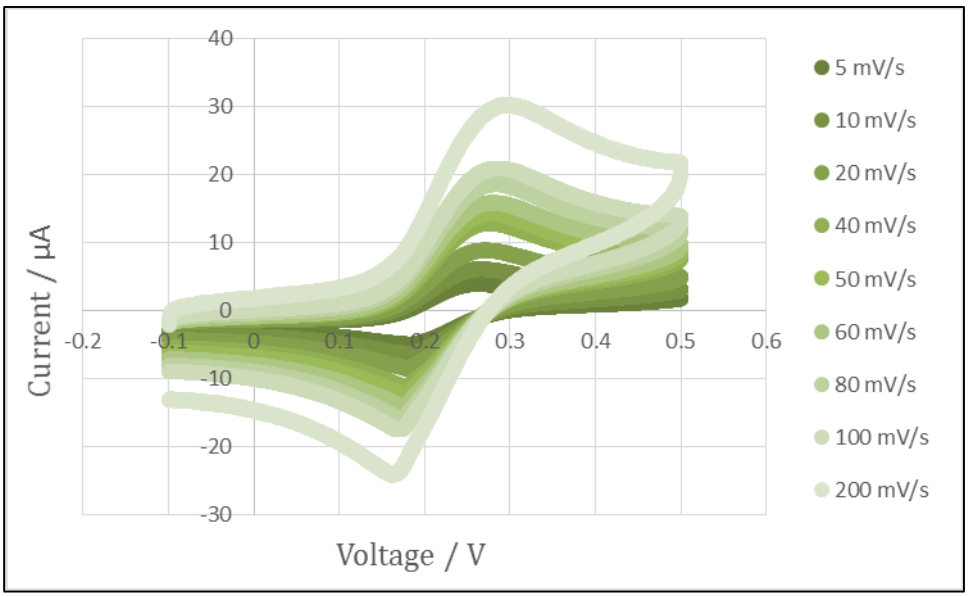

Figure 98: CVs recorded for CNT webs coated in a MCD film grown for 30 mins after electrospray pretreatment using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.

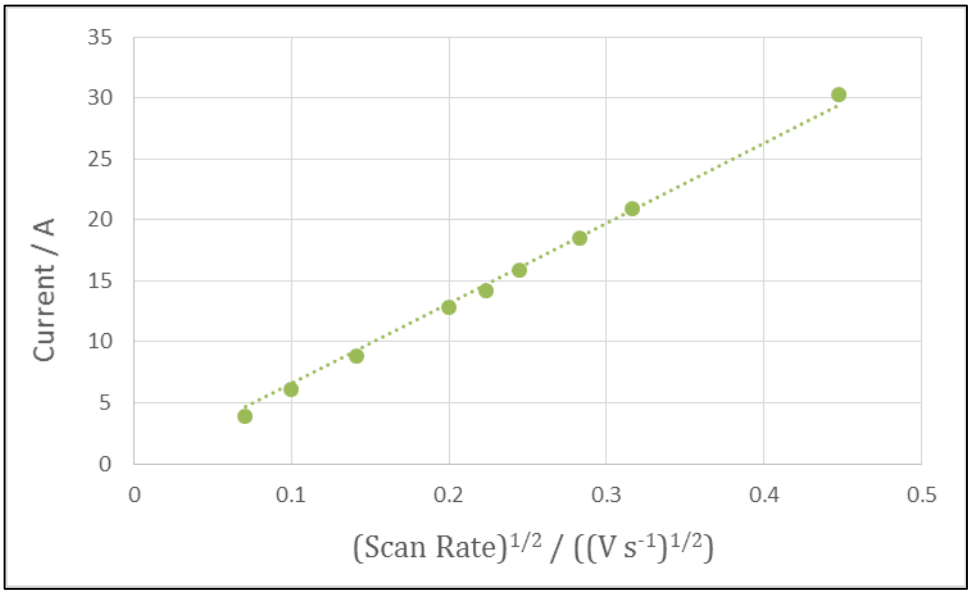

Figure 99: Plot of peak current vs square root of the scan rate for CNT webs coated in a MCD film grown for 30 mins after electrospray pretreatment using a 1 mM potassium ferricyanide with 1 M potassium nitrate supporting electrolyte solution.