Electrospun PCPU-SiC Nanofiber Capacitor

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Abstract

This research examines some basic parameters linked to electrospinning and the PCPU polymeric solution impregnated with Silicon Carbide (SiC) nanoparticles to produce fiber membranes. The results show the first experimental of capacitors, containing polymeric fibers of PCPU and SiC nanoparticles, where the nanofibers were produced by an electrospinning process.

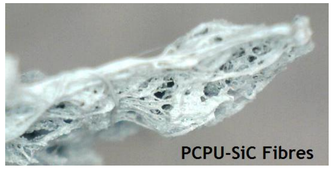


Figure 1: From sample 4

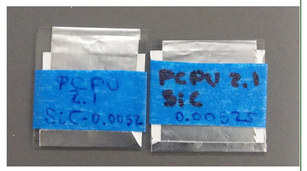
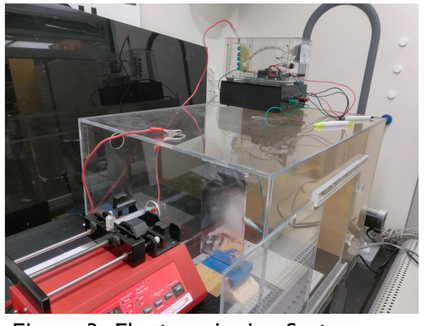


Figure 2: Capacitors

Background

PCPU is made of polymers polycarbonate (PC) and polyurethane (PU). They constitute 23% and 77% of the PCPU used. To make 1 gram of PCPU we need 0.77 grams of PU and 0.23 grams of PC.



The electrospinning uses an electric field to whip polymer solution PCPU-SiC into polymeric nanofibers. To make fibers it reaches the collector plate[1].

Figure 3: Electrospinning System

Objectives

1. To fabricate PCPU-SiC nanofibers.
2. To define a procedure to create PCPU-SiC nanofibers
3. To create and test an application of PCPU-SiC nanofibers.

Approach

This research was done with samples of 14, 16 and 18 w/v% solutions of PCPU using 90:10 ratio of THF: EtOAc. Also, 0.25 and 1w/w% of SiC nanoparticles were added. The component concentration table shows the final calculations and the final mass of PCPU, SiC, and solvents used for each sample.

Weight percent of Solution	SiC Nanoparticle w/w%							Mass of PCPU
	0.1	0.25	0.375	0.5	0.75	1	5	
14	0.0021	0.00525	0.00788	0.0105	0.01575	0.021		2.1
16	0.0024	0.006	0.009	0.012	0.018	0.024	0.12	2.4
18	0.0027	0.00675	0.01013	0.0135	0.02025	0.027		2.7

Table 1: Component Concentration

Experimental Results

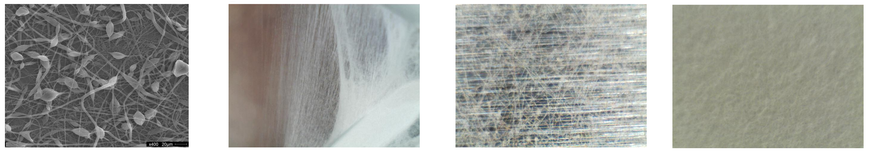


Figure 4: Pictures taken in four different places of the Sample 3: right, left, top, and center of the sample 3.

PCPU	Sample 1 (2.7 mg)	Sample 2 (2.4 mg)	Sample 3 (2.1 mg)	Sample 4 (2.7 mg)
SiC Nano	None	0.024 mg	0.021	0.027
WPS	18	16	14	18
Distace	12.7 cm/5 inches	12.7 cm/5 inches	12.7 cm/5 inches	12.7 cm/5 inches
Rate	20 microliter/min	20 microliter/min	20 microliter/min	20 microliter/min
Volume	1.5 ml	1.5 ml	1.52 ml	1 ml
Inside syringe	8.585 mm	8.585 mm	8.585 mm	8.585 mm
Syringe	3 ml/22G	B-D 3 ml 25G5/8	3 ml/Regular 27Gx1	3 ml/Regular 27Gx1
Power	24 kV	24 kV	24 kV	24 kV

Table 2: Summary of process and parameters used in four PCPU-SiC samples

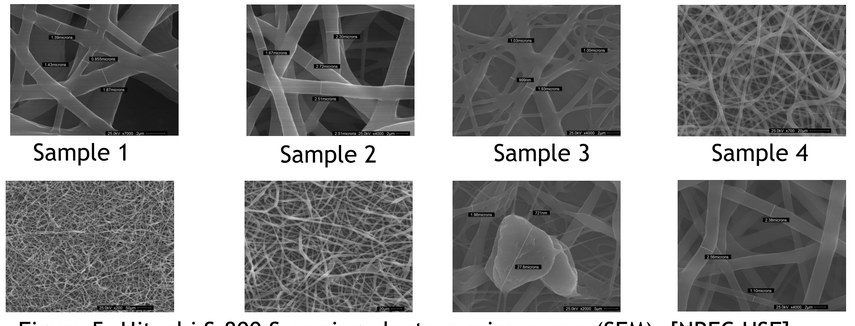
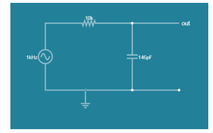


Figure 5: Hitachi S-800 Scanning electron microscope (SEM), [NREC USF], was used to magnify 300,000 times the above samples size

Analysis

We present the results for two capacitors using PCPU-SiC nanoparticles as the dielectric material. Voltages between 100 mV – 5.28 V and frequencies between 1kHz-3MHz, were used during the testing process.



Fcia	Vs	Vc
1	5.28	5.2
5	5.28	5.2
10	5.28	5.12
25	5.28	4.72
50	5.28	3.76
75	5.28	3
100	5.28	2.44
250	5.2	1.08
500	5.2	0.6
750	5.12	0.37
1000	5.12	0.28
2000	4.88	0.13
2500	4.64	0.1
3000	4.48	0.09

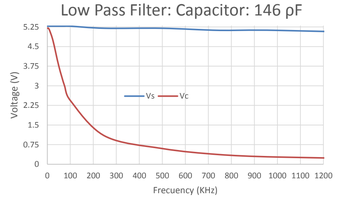
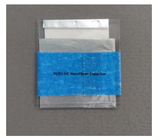
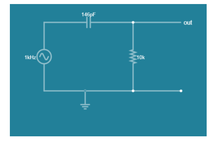


Figure 6: Low Pass Filter



Capacitor 146pF

Fcia	Vs	VL
1	5.28	0.4
5	5.28	0.224
10	5.28	0.44
25	5.28	1
50	5.28	1.58
75	5.28	1.86
100	5.2	2
200	5.16	2.18
250	5.2	2.24
500	5.12	2.24
750	5.12	2.28
1000	5.12	2.24
1500	5	2.24
2000	4.88	2.2
2500	4.72	2.16
3000	4.32	2.12



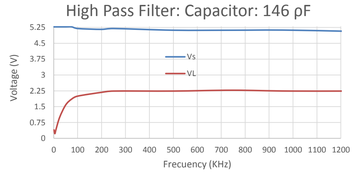


Figure 7: High Pass Filter

Conclusions

The PCPU-SiC micro fibers present an adequate dielectric behavior. Future works could test for behavior in response to high temperature and high power.

SiC nanoparticles could be combined with polymers, to allow for surface interactions in various applications such as: aircraft and aerospace, sensors, special electronic package, filters, and biomedical systems.

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