# SIIC067

## EXPLORING THE PARAMETER FOR ALTERNATING CURRENT ELECTROPHORETIC DEPOSITION OF CARBON NANOTUBES-POLYANILINE: A REVIEW

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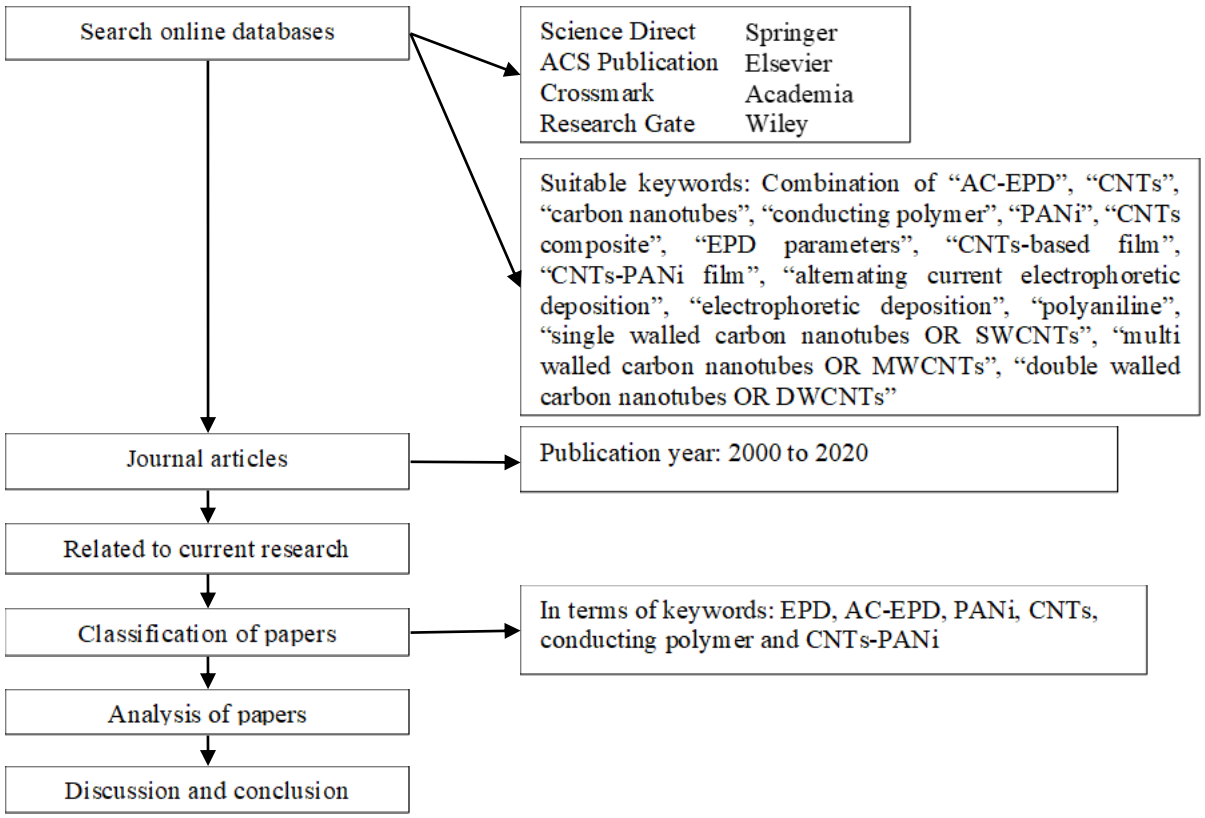
***Abstract:***
CNTs-based materials have attracted many attentions for their outstanding chemical properties such as tensile strength and electrical conductivity. The CNTs-based materials can be deposited either using DC-EPD and AC-EPD techniques. This review specifically discusses the important parameter for alternating current electrophoretic deposition of CNTs – PANi. The information related to this review is obtained from previous studies from year 2000 to 2020. The parameter for AC-EPD can be categorized into two which are parameter related to suspension and parameter related to AC-EPD process. Both category of parameter can affect the uniformity of the dispersion of CNTs. Based on previous studies, a uniform and homogenous CNTs dispersion can be obtained by using electric field more than 20 V $cm^{-1}$, peak to peak voltage in range of 0.5 V to 40 V, 300 nm distance between plate and 30 minutes or lower deposition time. Sinusoidal waveform with duty cycle of 80% can be used to deposit the CNTs as these properties are commonly used for AC-EPD. The frequency for deposition of CNTs mostly used is below 50 Hz.

***Keywords*:**
Alternating current electrophoretic deposition (AC-EPD); Electrophoretic deposition (EPD); Carbon nanotubes (CNTs); Polyaniline (PANi); AC-EPD parameters

***Objectives:***

- To determine the important parameter for AC-EPD of CNTs – PANi.

***Methodology:***




***Results:***

***Parameters related to suspension***

***i) Dispersant***

Chemical approaches are commonly used for dispersion of CNTs which include covalent and non-covalent method. The covalent method involves chemical such as ozone and HNO3/H2SO4 to improve the solubility of CNTs in the suspension. While non-covalent method is characterized by the interaction of van der Waal or π-π stacking. Non-covalent method include dispersant such as polymers, surfactants, aromatic compounds, and natural organic matter. Dyes also commonly used as the co-dispersant to prepare the colloid.

***ii) Medium of suspension***

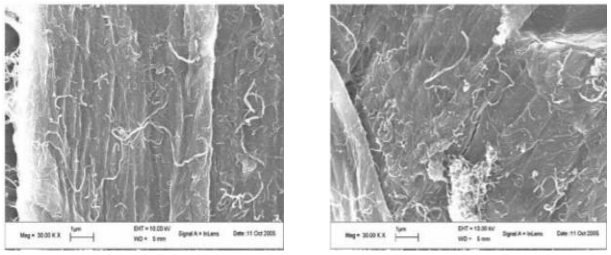
There are several types of suspension has been used to disperse CNTs which are ethanol, distilled water, and acetone. While the organic solvent can be used are n-pentanol, isopropyl alcohol, tetrahydrofuran (THF), ethyl alcohol and dimethylformamide (DMF). Based on previous study, CNTs usually has low and positive zeta potential values in acidic region (pH 5 to 8).

***iii) Conductivity of suspension***

The movement of particles slower if the conductivity is too high because the zeta potential is reduced. In contrast, the particles lost stability and become resistive if the conductivity too low. Based on previous study, applying electric field more than 20 V $cm^{-1}$ has shown a homogenous and uniform CNTs deposition.

***Parameters related to AC-EPD parameters***

***i) Period of deposition***

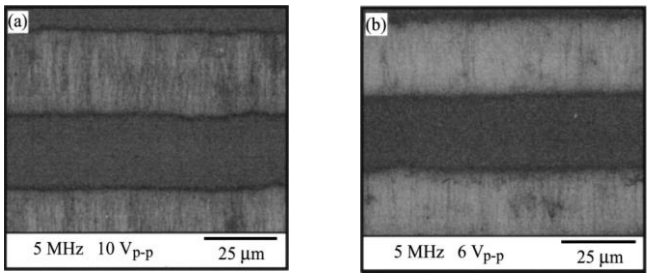


(a) (b)

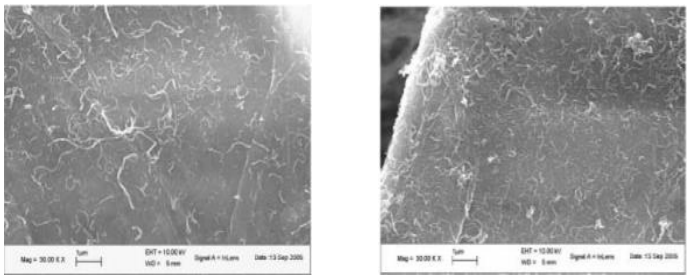
***ii) Waveform and duty cycle***

Typical waveform used for AC-EPD of CNTs is sinusoidal waveform with duty cycle of 80%.

***iii) Peak to peak voltage***




***iv) Frequency***



(a) (b)

***v) Distance between plate***

Previous studies reported that CNTs are aligned well between the two Au electrodes at peak to peak voltage of 10 V and frequency of 13 MHz with distance between plate of 300 nm.

***Conclusion:***

In conclusion, parameters for AC-EPD is divided into parameters related to suspension and parameters related to AC-EPD process. It is found that peak to peak voltage in range of 0.5 V to 40 V are commonly used for AC-EPD of CNTs. The frequency for deposition can be increased up to 10 MHz. However, the typical frequency used for AC-EPD of CNTs is mostly below 50 Hz. According to previous studies, a uniform and homogenous CNTs dispersion can be obtained with electric field more than 20 V cm-1, peak to peak voltage of 10 V, 300 nm distance between plate and 30 minutes or lower deposition time. Sinusoidal waveform with duty cycle of 80% commonly used to deposit the CNTs using AC-EPD.