

# The Dopan Influence to Electrical Properties of Nanofibre Polyaniline Synthesize by Interfacial Polymerization

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**Abstract**—The study observed the effect of variations in the electrical properties of dopants molarity polyaniline nanofiber. Polyaniline nanofiber in this study is synthesized by the interfacial polymerization method in Toluene Aniline 0.31 with the APS 4mmol dopant HCl solution with molarity between 0.6 M to 2.4 M. The synthesis results obtained were characterized by Scanning Electron Microscope. The electrical property is also observed on the polyaniline nanofiber. The results of this study indicate that the increase in molarity of dopants affect the incremental conductivity and diameter of fiber of the material.

**Keywords**—*polyaniline; nanofiber; dopant*

## I. INTRODUCTION

Currently polymeric conducting nanoparticles grows rapidly among polyaniline. Polyaniline nanoparticles have electrical and optical characteristics better than polyaniline macro molecules thus enabling broad application as sensor materials, catalysts and composite [1]. As a Conductive polymer material, polyaniline is selected due to its high sensitivity, short response time at room temperature and in synthesis tools. Electrical properties polyaniline can be modified by doping redox (variations number of electrons) or acid doping protonic (variation number of protons)(Fig.1). Polyaniline on condition protonated emeraldine have semiconducting behavior with a  $10^0$  S/cm conductivity, into polymer if  $< 10^{-9}$  S/cm conductivity and approached metal behavior with conductivity  $>10^4$  S/cm [2].

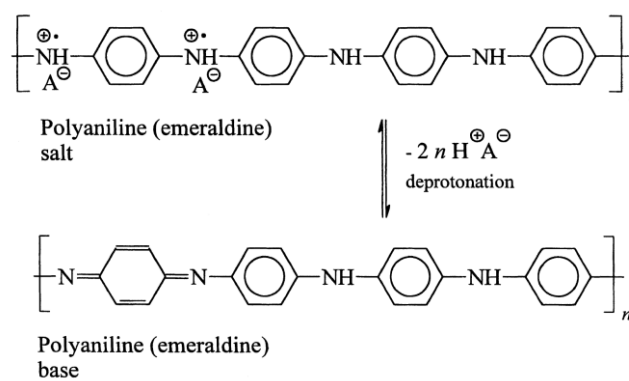


Figure 1. Deprotonation polyaniline salt in alkaline medium to polyaniline base A<sup>-</sup> is an arbitrary anion, e.g.,chloride [2]

Polyaniline nanofiber have a wide spread of specific surface. Extensive Surface of the nanofiber polyanilin cause molecular diffusion process into the structure nanofiber polyaniline go faster and have deeper penetration of molecules, this impact on the increase in sensor sensitivity and responsibility [3]. Polyaniline nanofiber also have biocompatibility and excellent electrical properties that improve the performance of the biosensor [4].

The synthesis conditions also affect conductivity, crystallinity and efficiency results. [5]. The electrical conductivity of polyaniline nanostructures approximately 850 times greater than the bulk polyaniline. The electrical conductivity increases with increasing temperature, this is indicating semiconducting behavior.[6]. The presence of dopants also influential in the polymerization of nanofiber poliani, changes in dopant effect on the diameter of the fiber arrangement [7].

This paper described the effect at Molar variation of the electrical properties of HCl doped polyaniline nanofiber. In addition it was also observed morphological changes

associated with increased dopant molarity. To obtain a polyaniline nanofiber synthesis, it was carried interfacial polymerization between APS, HCl and water as the aqueous phase and aniline and toluene as organic phase. Polyaniline nanofibres were then characterized to see the effect of dopants on the molarity of the electrical properties of materials. In section of experimental procedure, several works were carried out to set up the experiment of the interfacial polymerization of aniline monomer. Hydrochloric acid was added in various concentrations to produce several samples of polyaniline nanofibers. Discussion from the result of the experiment was found in section result. Finally conclusion are given in the last section.

## II. EXPERIMENTAL

Polyaniline nanofiber obtained formed from the interfacial polymerization between the aqueous phase (dopants, initiator and water) and organic phase (organic solvent and aniline monomer). 0.32 M. Aniline 99.5% ( $C_6H_5NH_2$ ) was added to toluene ( $C_7H_8$ ) to get 50ml organic phase (aniline-toluene). Four mmol APS ( $(NH_4)_2S_2O_8$ ) was added to a solution of 37% HCl with various molar concentrations ranging from 0.6 M to 2.4 M to get 50ml water phase. Two solutions with different phase is mixed and allowed to stand overnight to complete the polymerization results taken in the form of polyaniline nanofiber.

Partly of nanofiber polymerization results which was obtained was dried and the other was placed on the substrate. To determine the morphology, SEM characterization of materials was carried out, while testing the electrical properties was conducted by using digital RCL meter. All materials used were analytical grade and manufactured by Merck Millipore.

## III. RESULT

### 3.1. Resistivity Measurement

Resistivity was measured by using digital precision LCR meter with constant voltage 1 volt and variable frequency in the range of 0 – 100 kHz.

Every increment of frequency the value of resistance is recorded with the constant injected voltage. In this work, the digital precision LCR meter gives the resistance value with the assumption that the sample has the internal series resistance ( $R_s$ ). The internal series resistance will ease the further step of analysis to take the model of the tested sample.

The result is given in Figure 2. It is observed that the resistance values are varied with the variation of injected frequency at constant voltage. It is common for every solid material that at high frequency the proximity effect will occur where the electrons prefer to flow through outer surface than inner side. This effect is also known as skin effect.

The highest value of internal series resistance of the sample is obtained at certain value of injected frequency while the voltage is remained constant. The peak points indicating the highest value of  $R_s$  for every variation of molarities presented in the same injected frequency but this peak points is different among the samples. This findings showed that the molarity play significant effect to the value of  $R_s$  at the same frequency.

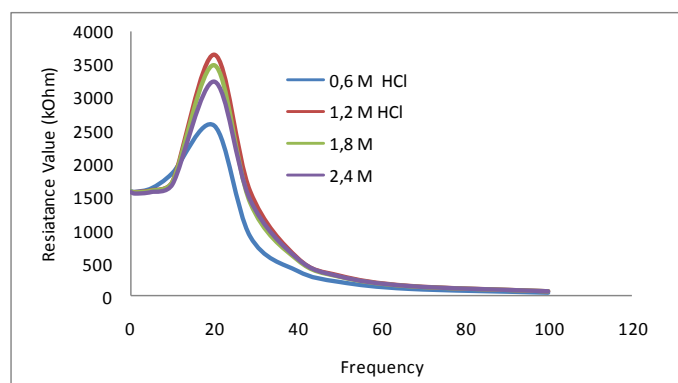


Figure 2. Resistivitas pada tegangan 1 v dan frekuensi 1 kHz

Further investigations at constant voltage and the same frequency for different samples are showed in Figure 3. The internal series resistance values obtained in Figure 3 are transform into conductivity as shown in Figure 4, by inverting the  $R_s$ . The result shows that the higher molarity of the tested samples, the material becomes more conductive. This is considered as important characteristic of nanofibre polyaniline. The conductive characteristic presented in this work justify that nanofibre polyaniline at certain molarity is classified as conductive polymer.

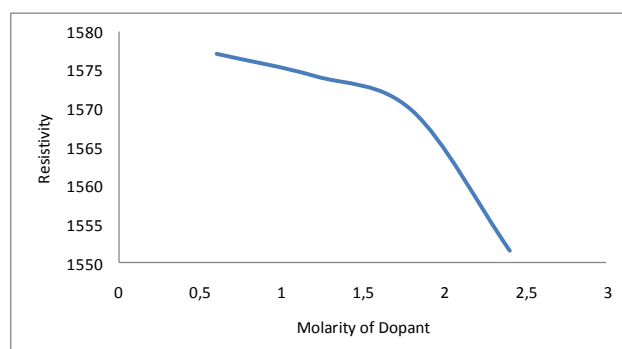


Figure 3. Resistivity as the function of molarity of dopant

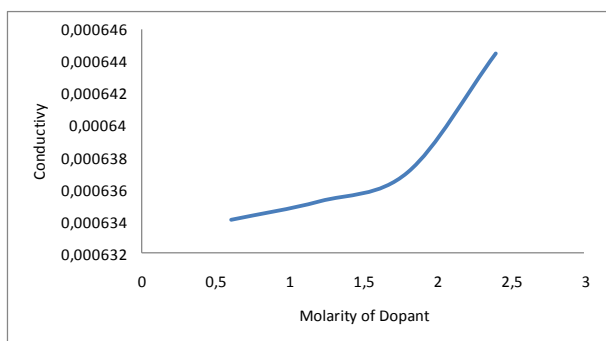


Figure 4 Conductivity as the function of molarity of dopant

### 3.2. Morphological analysis

Interfacial polymerization of conductive polymer nanostructures is strongly influenced by the doping concentration of the acid in the water phase (Huang Kaner 2004). Hydrogen Chloride is used in this case diluted with increasing molarity (0.6 to 2.4). The stronger concentration will increase the amount of H<sup>+</sup> ion content in the solution. Film morphology is also influenced by the presence of dopants. Variation of the resulting film morphology is also influenced by the presence of dopants. The greater the molar concentration, the size of the fiber (fiber size) will be smaller and shows more irregular structure as they are shown in Figure 5 – 8.

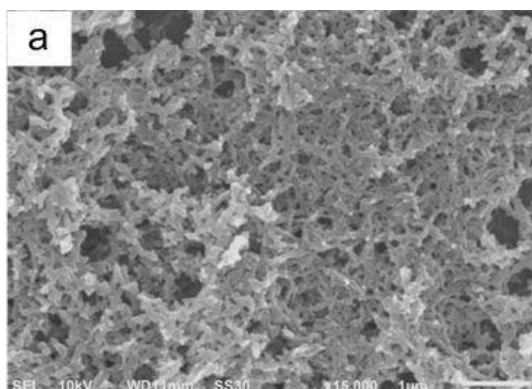


Figure 5. SEM Image of polyaniline nanofiber with dopant 0,6 M HCl

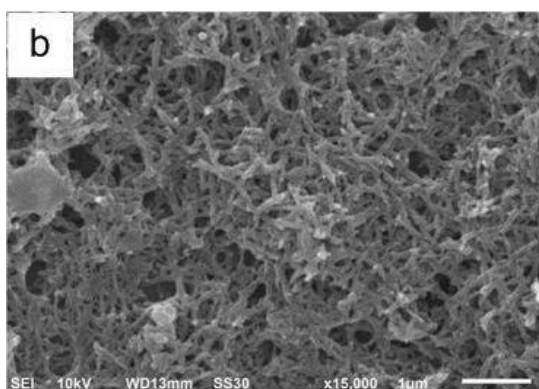


Figure 6. SEM Image of polyaniline nanofiber with dopant 1,2 M HCl

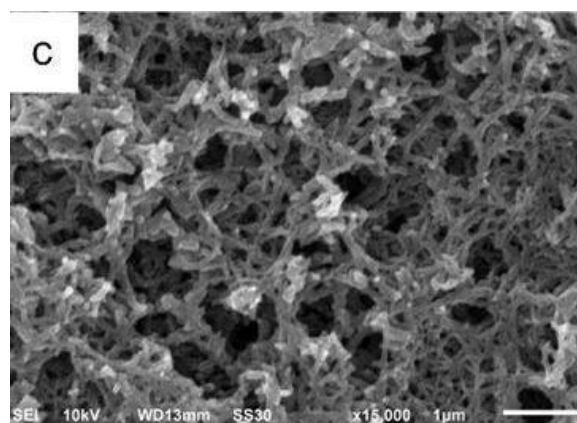


Figure 7. SEM Image of polyaniline nanofiber with dopant 1,8 M HCl

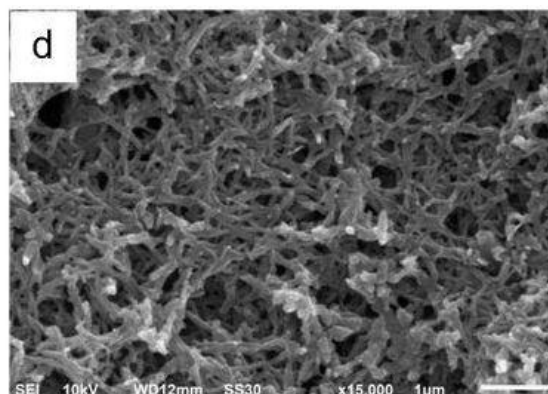


Figure 8. SEM Image of polyaniline nanofiber with dopant (a) 2,4 M HCl

## IV. CONCLUSION

The increment of molarity dopant during polymerization of aniline monomer certainly increases the electrical conductivity properties of polyaniline. Dopant HCl acid will affect the number of protons, an increase in molarity of the dopant will increase the number of existing proton conductivity of the material. The presence of dopant also affects the composition of the diameter of the fiber. The higher molarity of dopants will make the fiber to have smaller diameter and regular arrangement.

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