

***Faculty of Science***

***Department: Chemistry***

***Name: M.M.Ayad***

***Title: The effect of HCl on the polymerization of aniline with ferric chloride***

***Authors: M.M.Ayad & M. Whadan***

***Published In: Colloid journal,70( 2008).***

***Impact Factor:0.611***

***Abstract:***

The chemical oxidation of aniline with ferric chloride,  $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$  in the HCl aqueous solutions to form polyaniline (PANI) powder and films has been investigated. The effect of acid concentration on the deposition of PANI film in situ was studied. The presence of an acid affects both the yield of the polymer and the growth rate of the film. This effect was corroborated by the UV-visible absorption studies of the films deposited on glass supports during the polymerization. The influence of the acid on the yield of the PANI powder formed in the bulk solution was also examined. We have found that the yield of the polymer formed either on the surface or in the bulk solution decreased with the increasing concentration of HCl. The effect of HCl concentration on the situ UV-visible absorption at the early stages of aniline polymerization is also discussed.

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*Department:chemistry*

*Name:Mohamed Mohamed Yousif Ayad*

*Title: Synthesis and characterization of polyaniline films using fenton reagent*

*Authors: M.M.Ayad & E.A.Zaki*

*Published In: Journal of applied polymer science , 110 (2008)*

*Impact Factor: 1.008*

***Abstract:***

The chemical oxidation of aniline to form polyaniline (PANI) films and powder samples was made using Fenton reagent as an oxidizing agent in aqueous sulfuric acid medium. The PANI films were monitored by using the quartz crystal microbalance and the electronic absorption techniques. The optimum concentration was determined and the results were justified by measuring the UV-vis absorption spectra for the in situ PANI films. The conductivity for the PANI films and powder samples, prepared in different conditions, was measured. Also, the IR spectra, X-ray and the thermogravimetric analysis for the PANI powder formed in the bulk were measured and compared with the polymer prepared using ammonium peroxydisulfate. A preliminary investigation to the dielectric properties of the polymer powder was measured and discussed.

***Key Words:***

Fenton reagent  $\text{H}_2\text{O}_2\text{-Fe}^{2+}$  system; polyaniline, film, conductivity.

***Faculty of Science***

***Department: Chemistry***

***Name: Mohamed Mohamed Yosif Ayad***

***Title: Doping of polyaniline films with organic sulfonic acids in aqueous media and the effect of water on these doped films.***

***Authors: Mohamed M. Ayad & Eman A. Zaki***

***Published In: Europa polymer Journal 44(2008) 3741-3747***

***Impact Factor: 2.248***

***Abstract:***

Polyaniline (PANI) films in the form of emeraldine salt (ES) doped with aqueous organic sulfonic acids such as camphorsulfonic acid (CSA), p-toluenesulfonic acid (p-TSA) and dodecylbenzenesulfonic acid (DBSA) were studied. The ES films were obtained by treating the PANI in the form of emeraldine base (EB) with the aqueous solution of the acids. The dopant weight fraction ( $w$ ), which is related to the mass gain during the redoping of EB, was in situ determined using a quartz crystal microbalance (QCM). The behaviour of PANI doping with different acids indicates that the uptake shows a slow diffusion process. The kinetic of the doping reaction is dominated by Fickian diffusion kinetics. The diffusion coefficients ( $D$ ) of the dopant ions into the PANI chains were determined and were found to vary within the range of  $(1.6-18) \times 10^{-15} \text{ cm}^2\text{cm}^2\text{s}^{-1}$ . Moreover, the effect of water on these doped ES films was studied. The starting point is the fact that PANI-coated the electrode of QCM shows significant frequency shifts on exposure to water. The changes in the frequency as a function of treatment time in water were quantitatively measured. The response of the device suggests that the mass decrease under water exposure is due to dopant ions release. The latter films were dedoped by exposure to ammonia solution to obtain the EB film form. A further decrease in the mass of the films was observed. The percentage of the mass loss due to water exposure is found to be less than  $w$  determined during the dedoping process.

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*Department: Chemistry*

*Name: Mohamad M. Ayad*

*Title: Quartz crystal microbalance sensor coated with polyaniline emeraldine base for determination of chlorinated aliphatic hydrocarbons*

*Authors: Mohamad M Ayad, Gad El-Hefnawey & Nagy L. Torad*

*Published In: Sens. Actuators B: Chem. 134 (2008)*

*Impact Factor:2.331*

***Abstract:***

A quartz crystal microbalance (QCM) sensor coated with thin film of polyaniline emeraldine base (EB) was used as a sensitive method for the determination of a number of aliphatic chlorinated hydrocarbons such as carbon tetrachloride, chloroform, dichloromethane, 1,2-dichloroethane vapours. The detection was based on the absorption of the vapours of these organic compounds into the EB film. The frequency shifts due to the absorption of the chlorinated hydrocarbons were measured and calibration curves were plotted. The detection of these vapours can be obtained in part per million (ppm). The work includes also the use of a polyaniline emeraldine salt (ES) film instead of the EB film. It is concluded that the EB film has higher sensitivity towards the organic vapours than the ES film, which can be attributed to the presence of unprotonated amine and imine groups along the polyaniline (PANI) chains in the EB form.

*Faculty of Science*

*Department: Chemistry*

*Name: M.M.Ayad*

*Title: pH sensor based on polyaniline and aniline-anthracitic acid copolymer films using quartz crystal microbalance and electronic absorption spectroscopy.*

*Authors: M.M.Ayad, N.A.Salahuddin, A.K.Abou-Seif & M.M. Alghaysh*

*Published In: Polymers for advanced technologies, 19 (2008)*

*Impact Factor: 1.406*

***Abstract:***

The pH sensitivity based on conducting polyaniline (PANI) and copolymer of aniline and o-anthracitic acid (AA) films were studied using quartz crystal microbalance (QCM) technique and UV-Vis spectroscopy. The sensor was constructed from these polymer films coated on the electrode of the QCM. The resonant frequency changes as a function of pH in the range of 2012 were measured. These changes are quantitative indication of the degree of dedoping or redoping of the polymer films upon the subsequent exposure of the electrode to 0.25 M sulfuric acid and different pH solutions. There are two linear regressions between the frequency change and pH with two different and opposite slopes in the regions from 2 to 9 and 9 to 12. The pH sensitivity of the copolymer film was found to be less than using the PANI film. Thin films of PANI and copolymer, which were chemically polymerized in a fulfuric acid solution, were deposited onto the inner walls of the quartz cuvettes. The UV-vis absorption spectra of these films were measured in different pH solutions. Relations between the maximum absorption and its wavelength versus pH were constructed. The copolymer film shows some advantages over the PANI film. The difference between the PANI and copolymer films as pH sensors using the QCM and electronic absorption extends from the determination of  $pK_a$  for both films.

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*Department: Chemistry*

*Name: M.M.Ayad*

*Title: Study the effect of inorganic salts on the chemically polymerized aniline films using quartz crystal microbalance*

*Authors: M.M.Ayad & A.F. Rehab*

*Published In: Polymers for advanced technologies, (2008)*

*Impact Factor: 1.406*

***Abstract:***

The chemical oxidation of aniline with ammonium peroxydisulfate to form polyaniline (PANI) films has been studied in different aqueous acid mediums such as HCl, HNO<sub>3</sub>, and H<sub>2</sub>SO<sub>4</sub>. The yield and the growth rate of the PANI film deposition were measured using the quartz crystal microbalance (QCM) technique. The effect of different salts such as KCl, NaNO<sub>3</sub>, and K<sub>2</sub>SO<sub>4</sub> and their concentration on the yield and the growth rate of the film formation are investigated. The yield of PANI film deposition depends on the acid used and the type of salts as well as their concentration. When HCl and HNO<sub>3</sub> were used as media, the addition of salts with the same anion has no effect. However, when H<sub>2</sub>SO<sub>4</sub> was used as media, the addition of salts with the same anions as the medium enhances the yield of PANI film deposition. The UV-visible spectra of the produced PANI films in the absence and presence of the salts are also studied.

*Faculty of Science*

*Department: Chemistry*

*Name: M.M.Ayad*

*Title: Preparation and characterization of polyaniline films in the presence of N-phenyl-1,4-phenylenediamine*

*Authors: M.M.Ayad, A.F. Rehab, I.S. El-Hallag, W.A. Amer*

*Published In: European polymer Journal, 43 (2007)*

*Impact Factor: 1.152*

**Abstract:**

The chemical oxidation of aniline to form polyaniline (PANI) films was made in the presence of N-phenyl-1,4-phenyl-enediamine (PPDA) in aqueous hydrochloric acid medium. The PANI films were monitored by using the quartz crystal microbalance (QCM) technique. The effect of PPDA and its concentration on the film formation was investigated. It was found that PPDA decreases the yield of the PANI film, the induction period and the depletion time of the polymerization. However, the growth rate of the film formation was found to increase by increasing PPDA concentration. These results were justified by measuring the UV-VIS absorption spectra for the in situ PANI films and the in situ UV-VIS absorption spectra for the polymer in the bulk during the polymerization. The conductivity for the PANI films at different concentrations of PPDA was measured. Also, the IR spectra, X-ray and the thermal gravimetric analysis for the PANI powder formed in the bulk in the presence of PPDA were measured and discussed.

**Key words:**

Polyaniline film; quartz crystal microbalance, N-phenyl-1,4-phenylenediamine, In situ UV-VIS spectra, conductivity

***Faculty of Science***

***Department: Chemistry***

***Name: M.M.Ayad***

***Title: Determination of the dopant weight fraction in polyaniline films using a quartz-crystal microbalance***

***Authors: M.M.Ayad; E.A. Zaki & J. Stejskal***

***Published In: Thin solid films, 515 (2007)***

***Impact Factor: 1.569***

***Abstract:***

The electrical conductivity of polyaniline depends on factors such as degree of oxidation, type of protonation, and dopant weight fraction. The last of these factors is connected with the loss of mass during the deprotonation of polyaniline, and can thus conveniently be determined in situ by the use of quartz microbalance. This is illustrated in the present paper which concerns the determination of the weight fraction of acid in thin polyaniline films prepared by the chemical oxidation of aniline in the aqueous solutions of sulfuric and phosphoric acids. It is illustrated that the deprotonation reprotonation processes are fast, complete, and reversible. Polyaniline has sulfate counter-ions in 0.1 M sulfuric acid while, in 0.5-1 M sulfuric acid ; hydrogen sulfate counter-ions are present. The quartz microbalance involving polyaniline films can be used in the sensing of the acidity.

***Key words:***

Dopant weight fraction; polyaniline; polyaniline film, thin film, quartz crystal microbalance .

***Faculty of Science***

***Department: Chemistry***

***Name: M.M. Ayad***

***Title: Chemical synthesis and characterization of aniline and o-anthranilic acid copolymer***

***Authors: M.M. Ayad; N.A. Salahuddin, A.K. Abou-Seif, & M.O. Alghaysh***

***Published In: European polymer J.,44 (2008)***

***Impact Factor: 1.15***

***Abstract:***

The chemical co-polymerization of aniline with o-anthranilic acid (AA) to form copolymer films has been made in aqueous hydrochloric acid medium. The copolymer films were monitored by using the quartz crystal microbalance (QCM) technique. The effect of AA and its concentrations on the film formation was investigated. The results were justified by measuring the UV-Vis absorption spectra for the in situ copolymer films grown onto glass slides immersed into the polymerization media and the in situ UV-Vis absorption spectra for the copolymer in the bulk during the co-polymerization. The conductivity for the copolymer films and powder pellets at different molar ratios of aniline/AA were measured. Also, the IR spectra, X-ray diffraction and the thermal gravimetric analysis for the copolymer powder formed in the bulk in the absence and presence of AA were measured and discussed. It is found that the presence of AA affects the yield, induction period, depletion time and growth rate of the film formation. It also affects the crystallinity, and conductivity as well as the solubility of the polymer. Finally, the dopant weight fraction (w) associated with the copolymer was determined. It is almost half the value determined for the polymer in absence of AA.

***Key words:***

Polyaniline film, chemical, quartz crystal microbalance, o-Anthranilic acid; In situ UV-Vis absorption spectra.

***Faculty of Science***

***Department: Chemistry***

***Name: Mohamad M. Ayad***

***Title: Quartz crystal microbalance and spectroscopy measurements for acid doping in polyaniline films***

***Authors: Mohamad M. Ayad & Eman A. Zaki***

***Published In: Sci. Technol. Adv., 9 (2008)***

***Impact Factor: 0.42***

***Abstract:***

We investigated the doping of thin polyaniline (PANI) films, prepared by the chemical oxidation of aniline, with different acids. The initial step in the investigation is the preparation of PANI films from aqueous hydrochloric acid solution. This is followed by dedoping with ammonia to obtain a PANI base, which is subsequently doped with strong acids. (e.g. hydrochloric, sulfuric, phosphoric and trichloroacetic acids ) and with a weak acid (acetic acid). The dopant weight fraction ( $w$ ), which is connected with the gain of mass during the doping of PANI, was determined in situ using a quartz crystal microbalance (QCM). The behavior of PANI upon doping with different anions derived from strong acids indicates that both proton and the anion uptake into the polymer chains occur sharply, rapidly, completely, and reversibly. However the uptake in the case in acetic acid is characterized by slow diffusion. The doping was studied at different concentrations of acetic acid. A second cycle of dedoping-redoping was also performed. The kinetics of the doping reaction is dominated by Fickian diffusion kinetics. The diffusion coefficients ( $D$ ) of the dopant ions into the PANI chains were determined using the QCM and by UV-Vis absorption spectroscopy in the range of  $(0.076-1.64) \times 10^{-15} \text{ cm}^2 \text{ s}^{-1}$ . It was found that  $D$  in the second cycle of doping is larger than that evaluated from the first cycle of doping for high concentrations of acetic acid.  $D$  for the diffusion and for the dopant ion expulsion from PANI chains was also determined during the redoping process. It was found that  $D$  for acetic acid ions in the doping process is larger than that calculated for the dedoping process.

***Key words:***

Diffusion, acid doping, polyaniline film, thin film, quartz crystal microbalance

