

Fabrication of yttria dispersed duplex stainless steel electrode to determine dopamine, ascorbic and uric acid electrochemically by using cyclic voltammetry

R. Shashanka^{1*}, D. Chaira¹, B.E. Kumara Swamy²

¹Department of Metallurgical and Materials Engineering, National Institute of Technology Rourkela-769008, India.

²Department of P.G. Studies and Research in Industrial Chemistry, Kuvempu University, Jnana Sahyadri, Shankaraghatta 577451, Shimoga, Karnataka, India.

* Corresponding author:

E-mail address: shashankaic@gmail.com

Abstract— The elemental Fe-18Cr-13Ni was mechanically alloyed in a dual drive planetary mill for 10h to prepare nanostructured duplex stainless steel powder. The prepared duplex stainless steel powder was mixed with 1wt% Y₂O₃ nano particles in a turbula mixer for 2h. The yttria dispersed duplex stainless steel powder was characterized by XRD, SEM and particle size analysis. Yttria dispersed duplex stainless steel powder of 2, 4, 6, 8, 10 and 12mg concentrations were modified individually with carbon paste electrode to investigate the electro catalytic response of the fabricated electrode. Yttria dispersed duplex stainless steel modified carbon paste electrode (YDMCPE) shows splendid electrochemical sensitivity towards the oxidation of dopamine (DA), ascorbic acid (AA) and uric acid (UA) than yttria free duplex and bare carbon paste electrode (BCPE). 8mg YDMCPE show maximum anodic peak current in detecting 2mM DA in 0.2M phosphate buffer solution of pH 7.2 at scan rate 100mVs⁻¹. We studied the effect of scan rate, effect of concentration of analyte used and the effect of pH in detecting DA, AA and UA. All the above studies depicts that YDMCPE show better electro catalytic response towards anodic oxidation of DA, AA and UA because of its fast response, reliable, material maculating resistance and stable nature.

Index Terms— Duplex stainless steel, Cyclic voltammetry, Dopamine, Ascorbic acid, Uric acid, Carbon paste.

1 INTRODUCTION

Some of the bioactive compounds like dopamine (DA), ascorbic acid (AA) and uric acid (UA) play a vital role in animals [1]. The deficiency of these bioactive compounds can cause many severe diseases; hence it is very important to measure the concentration of these bioactive compounds. Electrochemical methods proved to be the better methods to determine the above bioactive compounds than fluorometric [2, 3], chromatographic [4-6], spectrophotometric [7], chemiluminescent [8, 9] and capillary electrophoresis [10]. Cyclic voltammetry is one of the simple, efficient and popular electrochemical methods used to detect DA, AA and UA concentrations [11, 12]. Mammalian central nervous system contains naturally occurring catecholamine called DA and it plays a fundamental role in neurotransmission [13-15]. The deficiency of DA leads to the serious diseases like Schizophrenia and Parkinson's diseases [16]. DA possesses a very strong electrochemical response to its oxidation product dopamine-o-quinone [17]. It is very difficult to detect DA electrochemically in real biological samples due to the coexistence of other bioactive compounds such as AA. The AA exists at a much higher concentration than DA and undergoes oxidation nearly at same potential results in

the overlapping of the both the peaks. Therefore we fabricated yttria dispersed duplex stainless steel modified carbon paste electrode (YDMCPE) to detect DA and AA individually.

AA is a water soluble compound and commonly known as vitamin C and usually present in many types of plants. Its intravenous high dosage is used as chemotherapeutic and biological response modifying agent to improve immunity power [18]. The deficiency of AA can causes scurvy, gingival bleeding and its excessive intake lead to urinary stone, diarrhoea and stomach convulsion [19]. Poly (Eriochrome Black-T) [12], silver nanoparticles [1], poly (alanine) [16] can be used as modifiers to study the electrochemical response of DA and AA. Using above modifiers it is possible to measure the favourable electrostatic interaction between the negatively charged poly (Eriochrome Black-T) film and cationic species of DA/anionic species of AA.

UA is a diprotic, heterocyclic compound produced by metabolic breakdown of purine nucleotides. Its higher concentration leads to gout, kidney stones, diabetes etc. [20].

Some of the researchers determined the responses of DA, AA and UA electrochemically by using pre treated carbon paste

electrode [21] and surfactant induced Iron (II) Phthalocyanine modified carbon paste electrode [11]. They studied the effect of scan rate, effect of pH and effect of analyte concentration on the oxidation of DA, AA and UA. The pre treated carbon paste electrode had shown an excellent selectivity, sensitivity towards the determination of analyte.

It is very difficult to determine DA, AA and UA concentrations as they all possess almost same overlapping potentials. YDMCPE evidenced to be a better electrode which can resolve all the peaks of the DA, AA and UA individually.

The synthesise of nano structured duplex stainless steel powder by high energy dual drive planetary ball mill (DDPM) and the details of milling parameters, mill fabrication were explained by the authors in their previous publication [22]. The prepared duplex stainless steel powder was mixed with 1wt% of Y_2O_3 nano particles in a turbula mixer for 2h. Y_2O_3 is an air stable solid substance attracted the attention of material researchers due to its crystallographic stability at higher temperature. It possess high mechanical strength, high thermal conductivity, very good protective coating in highly reactive environments [23, 24] and is stable with graphite up to 1600°C [25]. Dispersed Y_2O_3 in duplex stainless steel improves the surface properties of electrode by imparting robust, covalently bound, hydrolytically stable layer, which is capable of being functionalised easily [26]. This results in the free movement of electrons between carbon paste and electrolytes.

Till now, only dyes, surfactants and polymer based modified carbon paste electrodes are reported. No literature is available so far related to yttria dispersed duplex stainless steel modified carbon paste electrodes to detect DA, AA and UA concentrations. But the author explained the electrocatalytic detection of folic acid by using duplex and yttria dispersed duplex stainless steel in their previous publication [27]. We studied the electro catalytic response of yttria dispersed and yttria free duplex stainless steel modified carbon paste electrode with respect to bare carbon paste electrode (BCPE). YDMCPE shows better electro catalytic response in oxidising all the three analyte compared to duplex modified carbon paste electrode (DMCPE) and BCPE. Hence YDMCPE and DMCPE were found to be a suitable sensor for the determination of DA, AA and UA.

2. Experimental part

2.1. Reagents and chemicals

Fe (99.5% pure), Cr (99.8% pure) and Ni (99.5% pure) elemental powders were purchased from loba chemicals and

Y_2O_3 (99.99%) was purchased from Alfa Aesar. Dopamine, ascorbic acid, uric acid, perchloric acid, sodium dihydrogen orthophosphate dehydrate and di-sodium hydrogen phosphate anhydrous of analytical grade quality was purchased from sd. Fine chemicals. All the above reagent solutions were prepared by dissolving in double distilled water. Graphite powder was purchased from Merck chemicals.

2.2. Apparatus

Milling of elemental Fe, Cr and Ni powders of duplex stainless steel composition (Fe-18Cr-13Ni) were carried out in a specially designed DDPM. Carbon paste electrode and duplex stainless steel powder morphology was characterized by scanning electron microscopy (SEM) using JEOL JSM-6480LV. X-ray diffraction (XRD) was carried out in PAN analytical Xpert Pro XRD. The particle size was measured by Malvern Mastersizer. The duplex stainless steel powders were mixed separately with 1wt. % nano structured Y_2O_3 powder particles by turbula shaker mixture (TURBULA® T2F, Willy A. Bachofen AG Maschinenfabrik, Switzerland) for 2hours. The electrochemical experiments were carried out using electrochemical work station CHI-660c model. All the experiments were carried out in a conventional three electrode system composed of working electrode (carbon paste electrode of 3mm diameter), a platinum wire as counter electrode and Ag/AgCl saturated KCl electrode as reference electrode. The pH of the buffer solutions was measured with the digital pH meter MK VI.

2.3 Preparation of Duplex stainless steel powders by DDPM

The elemental Fe, Cr and Ni powders of duplex stainless steel composition (Fe-18Cr-13Ni) is milled in DDPM for 10h using toluene to prevent oxidation. The composition of duplex stainless steel (Fe-18Cr-13Ni) is selected from Schaeffler diagram. The milling media consist of 1kg stainless steel balls of diameter 8mm and ball-to-powder weight ratio of 6:1 are maintained. The angular velocity of the jars and the supporting main shaft are kept at 620 and 275 rpm respectively. The detailed synthesis and mill fabrication part was explained elsewhere [22] by the author. The prepared duplex stainless steel powder sample is mixed with 1wt. % nano structured Y_2O_3 powder particles by turbula shaker mixture [28].

2.4 Fabrication of the carbon paste electrode

The graphite powder and silicon oil are mixed in an agitate mortar at a ratio of 70:30 for 30minutes to prepare bare carbon paste electrode (BCPE). DMCPE and YDMCPE can be fabri-

cated by hand mixing of duplex and yttria dispersed duplex stainless steel powder individually with 70:30 ratio of graphite powder and silicone oil using mortar pestle. The homogeneous carbon paste electrode was packed into a cavity of carbon paste electrode of 3mm diameter [29]. The YDMCPE was prepared by mixing 2, 4, 6, 8, 10 and 12mg of yttria dispersed duplex stainless steel powder individually along with graphite powder and silicon oil. After packing in to the cavity of electrode, the surface was smoothed by rubbing slowly on a piece of weighing paper. At the tube end, the electrical contact was provided by copper wire which is directly connected to the paste. The BCPE was prepared by without adding modifier.

3. Results and discussion

XRD and SEM microstructure of 0h and 10h milled duplex and yttria dispersed duplex stainless steel powders were explained by the authors in previous publications [30-33].

3.1 Particle size analysis

Properties of the materials vary as the particle size changes hence it is very important to know the size of the particles. The quality, performance, flow and compaction properties of any materials depend upon the size and shape of the powder particles [34].

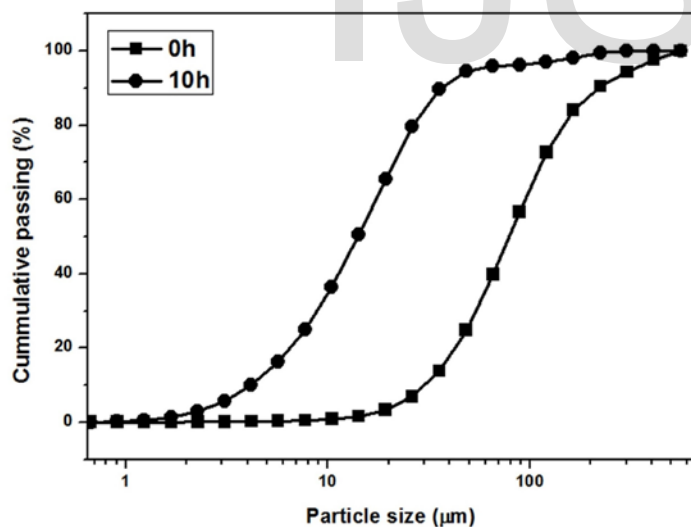


Fig. 1 Median particle size of duplex stainless steel powder at 0 and 10h

Fig. 1 represents the particle size distribution of duplex stainless steel powder milled in DDPM for 0h and 10h. As milling progress, the cumulative size distribution curves shift towards left side indicating the refinement and reduction of powder particles. From the graph it is confirmed that particle size of

duplex stainless steel powder decreases with increase in milling time. The initial median particle size is around 80μm and decreases with increase in milling time and becomes 14μm after 10h.

3.2 Electro catalytic response of DA at YDMCPE

3.2.1 Concentration variation of yttria dispersed duplex stainless steel powder

The efficiency of the electrode sensor depends upon optimum concentration of modifier. Hence it is very important to measure the redox current at optimum concentration level of modifier. We studied the effect of different concentrations of yttria dispersed and yttria free duplex stainless steel powder on the anodic peak current of 2mM DA.

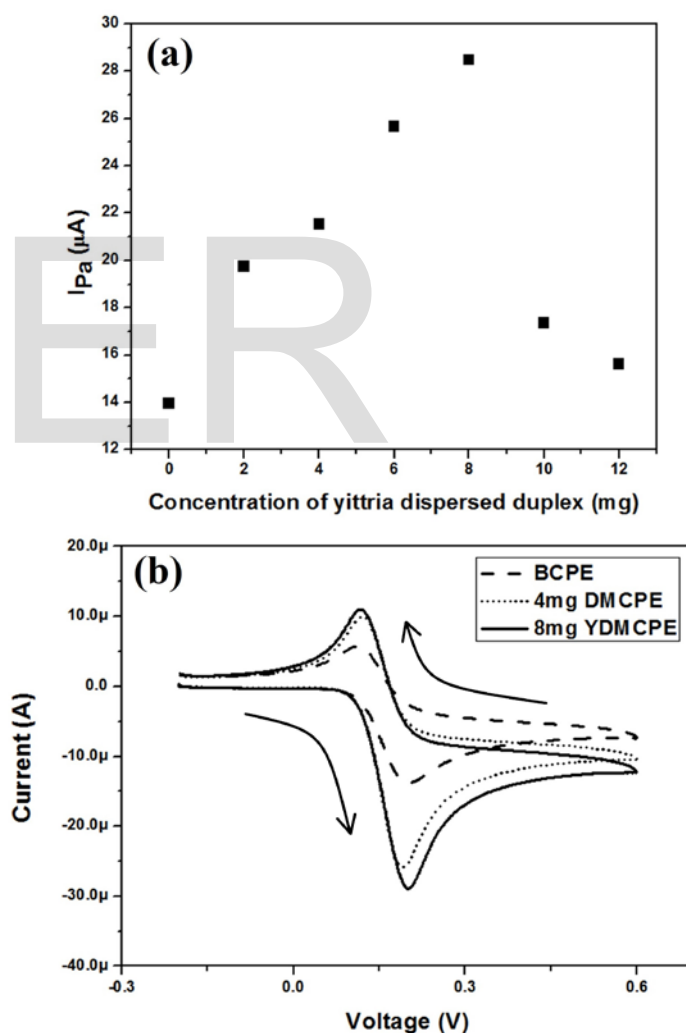


Fig. 2 (a) Plot of anodic peak currents with different concentration of yttria dispersed duplex stainless steel in 2mM DA (b) Cyclic voltammogram of bare carbon paste electrode (BCPE), 4mg DMCPE and 8mg YDMCPE in 2mM DA at 100mVs⁻¹ and in PBS of pH 7.2

The yttria dispersed duplex stainless steel powder concentra-

tion has been varied from 2mg to 12mg to study the electrochemical response of 2mM DA in 0.2M phosphate buffer solution (PBS) of pH 7.2 at sweep potential from -200 to 600mV and scan rate of 100mVs⁻¹. Fig. 2 (a) depicts the plot of anodic peak current with different concentrations of yttria dispersed duplex stainless steel. Among all, 8mg YDMCPE shows better electro catalytic response to oxidise 2mM DA. From the voltammogram it is clear that oxidation peak current increases with the increase in the concentration of modifier up to 8mg and then decreases with further increase in the concentration. This is due to the decrease in the number of oxidation sites in the paste and resultant reduction in the actual electrode area [35]. In case of yttria free duplex stainless steel, 4mg DMCPE shows maximum anodic peak current in detecting 2mM DA. Fig. 2 (b) shows the cyclic voltammogram of bare carbon paste electrode (BCPE), 4mg DMCPE and 8mg YDMCPE at 2mM DA in 0.2M phosphate buffer of pH 7.2 at a scan rate of 100mVs⁻¹. The anodic peak current of BCPE is 13.95μA, 4mg DMCPE is 25.61μA and 8mg YDMCPE is 28.48μA. YDMCPE shows maximum anodic peak current than DMCPE due to the presence of Y₂O₃ nanoparticles. The Y₂O₃ nanoparticles improve the surface properties of electrode and increase the bonding strength between carbon paste electrode and the modifier. Thereby increases the free movement of electrons between carbon paste electrode and electrolytes. Hence 8mg YDMCPE is selected as the modifier for the further determination of DA, AA and UA.

3.2.2 Effect of scan rate

Scan rate is varied from 50 to 500mVs⁻¹ in PBS of pH 7.2 to study the electrochemical behaviour of 2mM DA. The effect of scan rate is an important parameter which controls the kinetics of surface electrode reactions. Fig. 3 (a) shows the voltammogram of DA in 8mg YDMCPE at different scan rates. From the figure it is clear that the redox peak current increases linearly with increase in the scan rate. This is due to the direct electron transfer between DA and the modified carbon paste electrode surface. Increase in scan rate also increases anodic and cathodic peak potential difference [36]. The plot of anodic peak current vs scan rate is shown in the fig. 3 (b) and the plot shows linear relation between oxidation peak current and scan rate with correlation coefficient 0.9654. Similarly Fig. 3 (c) depicts the plot of anodic peak current vs. square root of scan rate and its correlation coefficient is 0.9040. This confirms the electrode process is adsorption controlled [21].

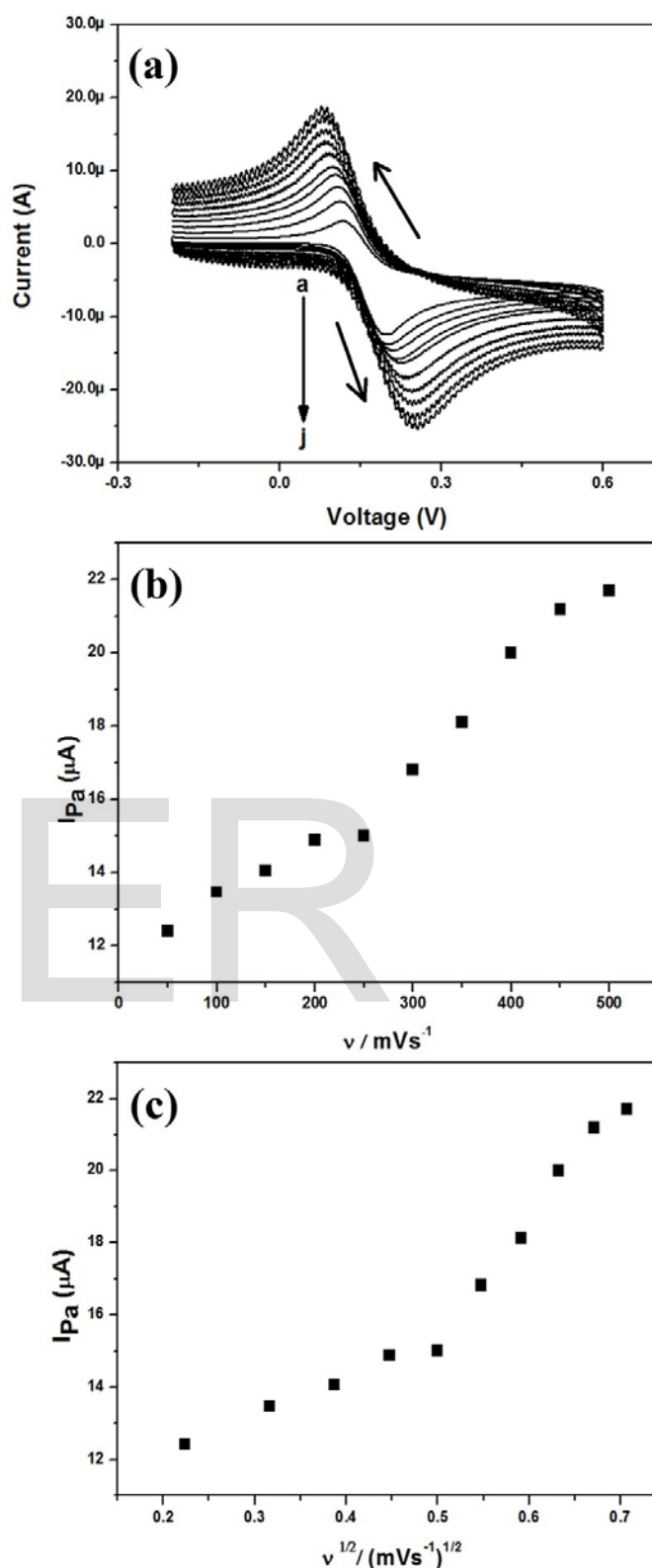


Fig. 3 (a) Cyclic voltammogram of 2mM DA at 50 to 500mVs⁻¹ scan rate (a=50, b=100,, j=500mVs⁻¹) in PBS of pH 7.2 (b) Plot of anodic peak current vs. scan rate (c) Plot of anodic peak current vs. square root of scan rate

3.2.3 Effect of Concentration of Dopamine

Usually anodic peak current increases with increase in the analyte concentration. Therefore we can expect the similar trend during electrochemical response of DA at 2 to 3mM concentration using 8mg YDMCPE at scan rate of 100mVs⁻¹. Fig. 4 (a) represents the cyclic voltammogram at different concentration of DA. From the voltammogram it is confirmed that anodic peak current increase with increase in concentration of DA. A plot of anodic peak current vs different concentration of DA is as shown in the fig. 4 (b).

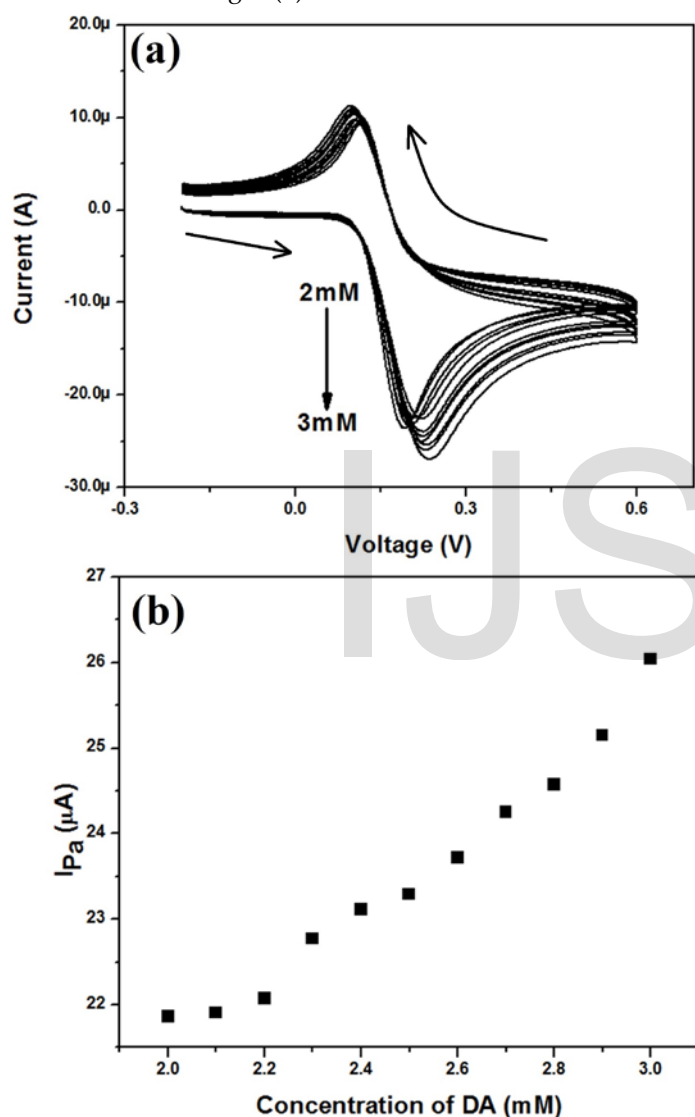


Fig. 4 (a) Cyclic voltammogram of 2 to 3mM concentration of DA at 100mVs⁻¹ in PBS of pH 7.2 **(b)** Plot of anodic peak current vs. different concentration of DA

Plot depicts the linear relationship between different concentration of DA and oxidation peak current with correlation coefficient of 0.9668. At a concentration of 2 to 2.2mM DA, the anodic peak current do not show linear relationship but from 2.2 to 3mM anodic peak current increases linearly as shown in

the plot. The anodic peak current at 2mM DA is 21.86μA and at 3mM DA concentration it increased to 26.04μA.

3.2.4 Effect of pH

Variation of pH values in buffer solution plays a very important role in determining the stability, selectivity and sensitivity of carbon paste electrodes. Hence selection of optimum pH solution increases the electrode performance. Therefore we studied the effect of pH variation on the peak potential of 2mM DA using 8mg YDMCPE at 0.2M phosphate buffer solution with scan rate of 100mVs⁻¹.

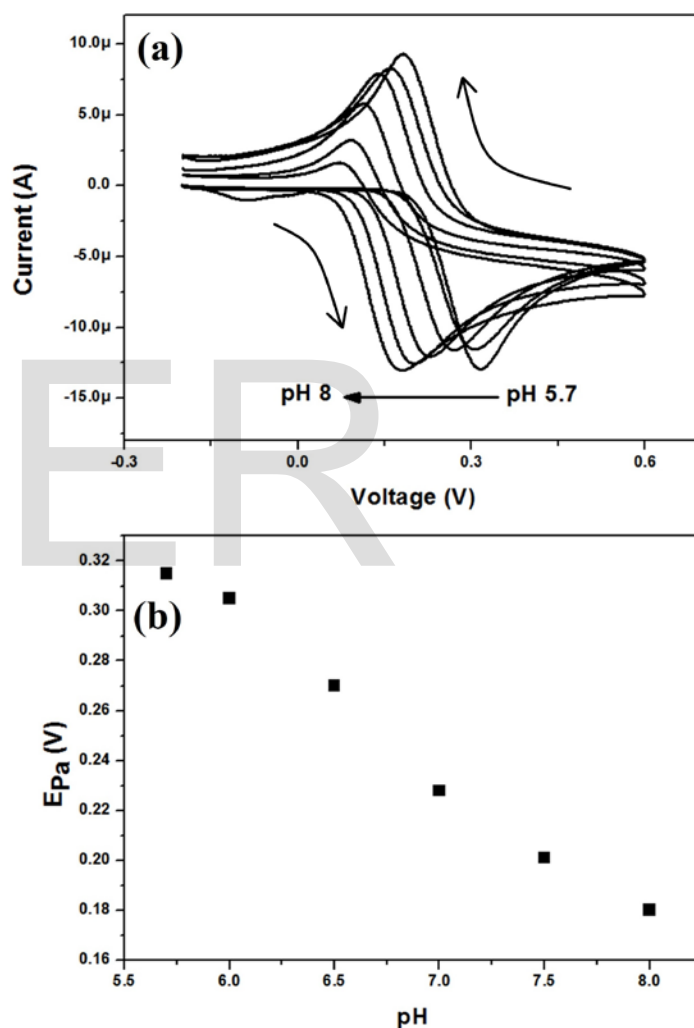


Fig. 5 (a) Cyclic voltammogram of 2mM DA at different pH of PBS buffer solutions at 100mVs⁻¹ **(b)** Plot of anodic peak current vs. different pH from values 5.7 to 8

The anodic peak potential of 2mM DA is measured at different pH from 5.7 to 8 and their voltammograms are shown in fig. 5 (a). From the voltammogram it is clear that anodic peak potential of 2mM DA is shifted to a lower potential side with the increase in pH. This is due to the enhanced rate of oxidation at

higher pH values. Cathodic peak potential also shift towards the lower potential side with increase in pH value but the rate of shift is very less. Anodic peak current goes on increasing with increase in the pH values due to the higher rate of oxidation at maximum pH. The higher rate of oxidation generates more number of electrons and the generation of more electrons increases the anodic peak current. Fig. 5 (b) represents the plot of pH vs anodic peak potential at 2mM DA. From the plot it is confirmed that anodic peak potential gradually decreases from pH 5.7 to 8 with correlation coefficient of 0.9858. The oxidation peak potential at pH 5.7 is 315mV and starts decreasing linearly to 180mV at pH 8. The graph has good linearity and it nearly obey the Nernst Equation for equal number of electron and proton transfer reactions [37].

3.3 Electro catalytic response of AA at YDMCPE

Generally AA coexists with DA, although AA exists at higher concentration than DA it is very difficult to measure the electrochemical response of both the analyte because both oxidise electrochemically at almost same potential. This results in the overlapping of voltammogram and leads to wrong results [14, 38, 39]. Hence we studied the electrochemical response of AA and DA individually which gives the correct results.

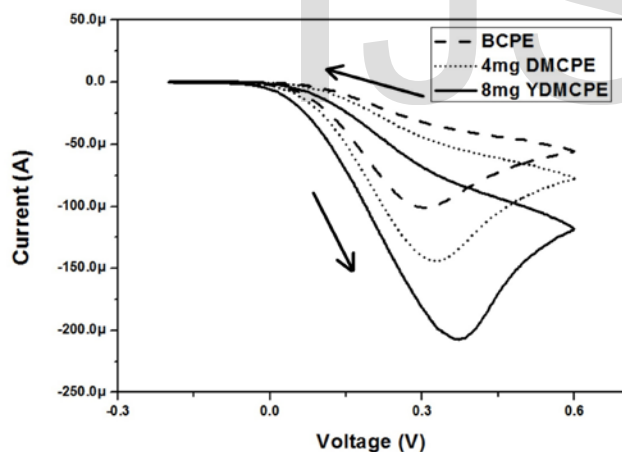


Fig. 6 Cyclic voltammogram of BCPE, 4mg DMCPE and 8mg YDMCPE in 2mM AA at 100mVs⁻¹ and in PBS of pH 7.2

Fig. 6 shows the cyclic voltammogram of BCPE, 4mg DMCPE and 8mg YDMCPE at 2mM AA in 0.2M phosphate buffer of pH 7.2 at a scan rate of 100mVs⁻¹. The anodic peak current of BCPE is 100.98μA, 4mg DMCPE is 144.06μA and 8mg YDMCPE is 206.55μA respectively. The presence of Y₂O₃ nanoparticles in YDMCPE increases the anodic peak current. The anodic peak current of YDMCPE is almost twice the anodic peak current of BCPE. This confirms that fabricated YDMCPE possess high selectivity, sensitivity and maximum electro cata-

lytic performance. The anodic peak potential of BCPE is 304mV, DMCPE is 325mV and that of YDMCPE is 370mV respectively.

3.3.1 Effect of scan rate

Fig. 7 (a) represents the cyclic voltammogram of 2mM AA at different scan rates.

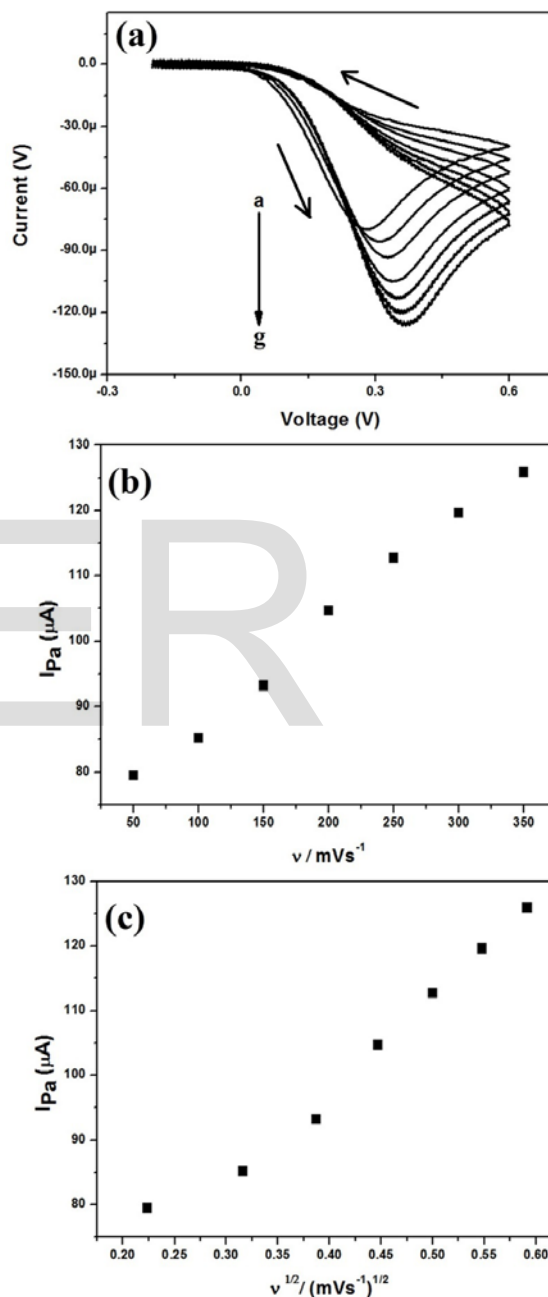


Fig. 7 (a) Cyclic voltammogram of 2mM AA at 50 to 350mVs⁻¹ scan rate (a=50, b=100, ..., g=350mVs⁻¹) in PBS of pH 7.2 **(b)** Plot of anodic peak current vs. scan rate **(c)** Plot of anodic peak current vs. square root of scan rate

Electro catalytic properties of 8mg YDMCPE is performed at

50 to 350mVs⁻¹ in PBS of pH 7.2 and 2mM AA. As scan rate increases from 50 to 350mVs⁻¹ both anodic peak current and anodic peak potential of AA increases. The plot of different scan rate vs. anodic peak current of 2mM AA at 100mVs⁻¹ in PBS of pH 7.2 is as shown in fig. 7 (b). The oxidation peak current increases linearly as shown in the plot and it increase from 79.42 to 125.9μA at a scan rate of 50 to 350mVs⁻¹. The correlation coefficient is found to be 0.9913 and this reveals that adsorption controlled electrode processes. Fig. 7 (c) depicts the plot of square root of scan rate vs. anodic peak current of 2mM AA. The correlation coefficient is found to be 0.9726 and electrode process is adsorption controlled.

3.3.2 Effect of Concentration of Ascorbic acid

Fig. 8 (a) depicts the cyclic voltammogram of different concentrations of AA at 100mVs⁻¹ in PBS of pH 7.2.

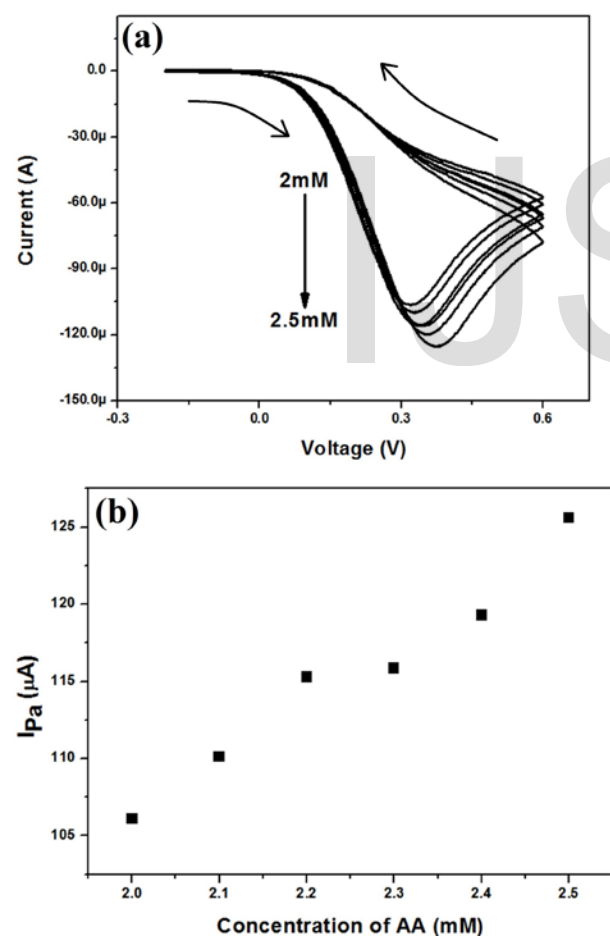


Fig. 8 (a) Cyclic voltammogram of 2 to 2.5mM concentration of AA at 100mVs⁻¹ in PBS of pH 7.2 (b) Plot of anodic peak current vs. different concentration of AA

The anodic peak current increases linearly with the increase in AA concentration from 2mM to 2.5mM in an electrochemical

cell. Oxidation peak current increases from 106.10μA to 125.61μA at 2mM to 2.5mM AA concentration. The oxidation peak potential shifts towards higher value with increase in AA concentration. At higher concentrations, the number of AA molecules is more therefore more potential is required to oxidise AA and hence more peak potential at higher concentration. At 2mM of AA concentration, the oxidation peak potential is found to be 322mV and that at 2.5mM is 373mV. Plot of anodic peak current vs different concentrations of AA is shown in fig. 8 (b) and it shows linear relationship with correlation coefficient of 0.9549.

3.3.3 Effect of pH

It is very important to select optimum pH value in which carbon paste electrodes can perform better and gives good results.

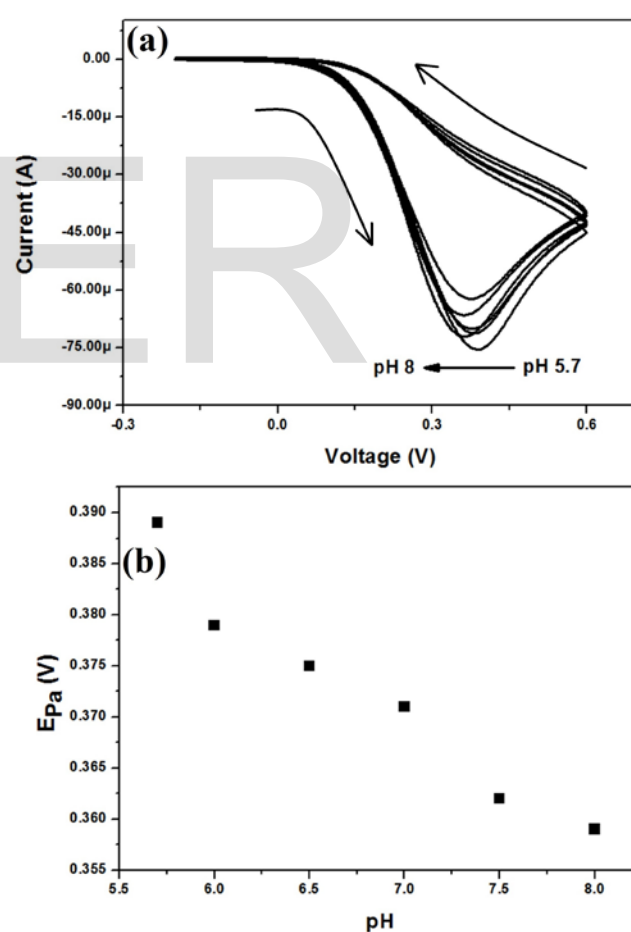


Fig. 9 (a) Cyclic voltammogram of 2mM AA at different pH of PBS buffer solutions at 100mVs⁻¹ (b) Plot of anodic peak current vs. different pH from values 5.7 to 8

We reported the effect of pH variation on the oxidation peak potential of 2mM AA using 8mg YDMCPE at 0.2M phosphate

buffer solution with scan rate of 100mVs^{-1} . Fig. 9 (a) shows the cyclic voltammogram of 2mM AA measured at different pH from 5.7 to 8. The anodic peak potential of 2mM AA is shifted towards a lower potential side with the increase in pH due to higher rate of oxidation. Fig. 9 (b) represents the plot of pH vs. anodic peak potential at 2mM AA. The anodic peak potential decreases linearly from pH 5.7 to 8 as shown in the plot and the correlation coefficient is found to be 0.9447. At pH 5.7 the oxidation peak potential is 389mV and at pH 8 it is decreased to 359mV respectively.

3.4 Electro catalytic response of UA at YDMCPE

Fig. 10 represents the cyclic voltammogram of BCPE, 4mg DMCPE and 8mg YDMCPE at 2mM UA in 0.2M phosphate buffer of pH 7.2 at a scan rate of 100mVs^{-1} . The YDMCPE shows maximum anodic peak current than BCPE and DMCPE. The anodic peak current of BCPE is $14.34\mu\text{A}$, 4mg DMCPE is $19.36\mu\text{A}$ and 8mg YDMCPE is $31.01\mu\text{A}$ respectively. The anodic peak current of YDMCPE is more than two times the anodic peak current of BCPE. This confirms that, the fabricated YDMCPE possess high selectivity, sensitivity and maximum electro catalytic performance. Therefore 8mg YDMCPE acts as a better electrochemical sensor in detecting UA at very low concentrations.

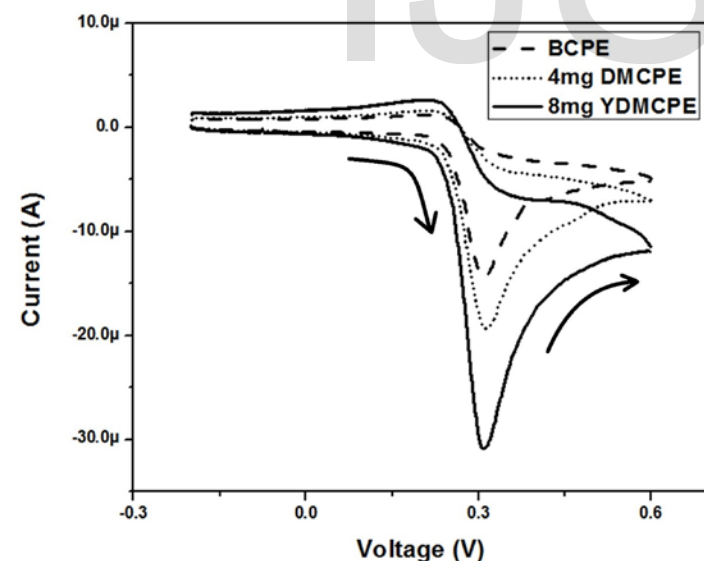


Fig. 10 Cyclic voltammogram of BCPE, 4mg DMCPE and 8mg YDMCPE in 2mM UA at 100mVs^{-1} and in PBS of pH 7.2

3.4.1 Effect of scan rate

Fig. 11 (a) shows the cyclic voltammogram of 2mM UA at scan rate of 50 to 300mVs^{-1} in PBS of pH 7.2. Anodic peak current and anodic peak potential goes on increasing with increase in the scan rate.

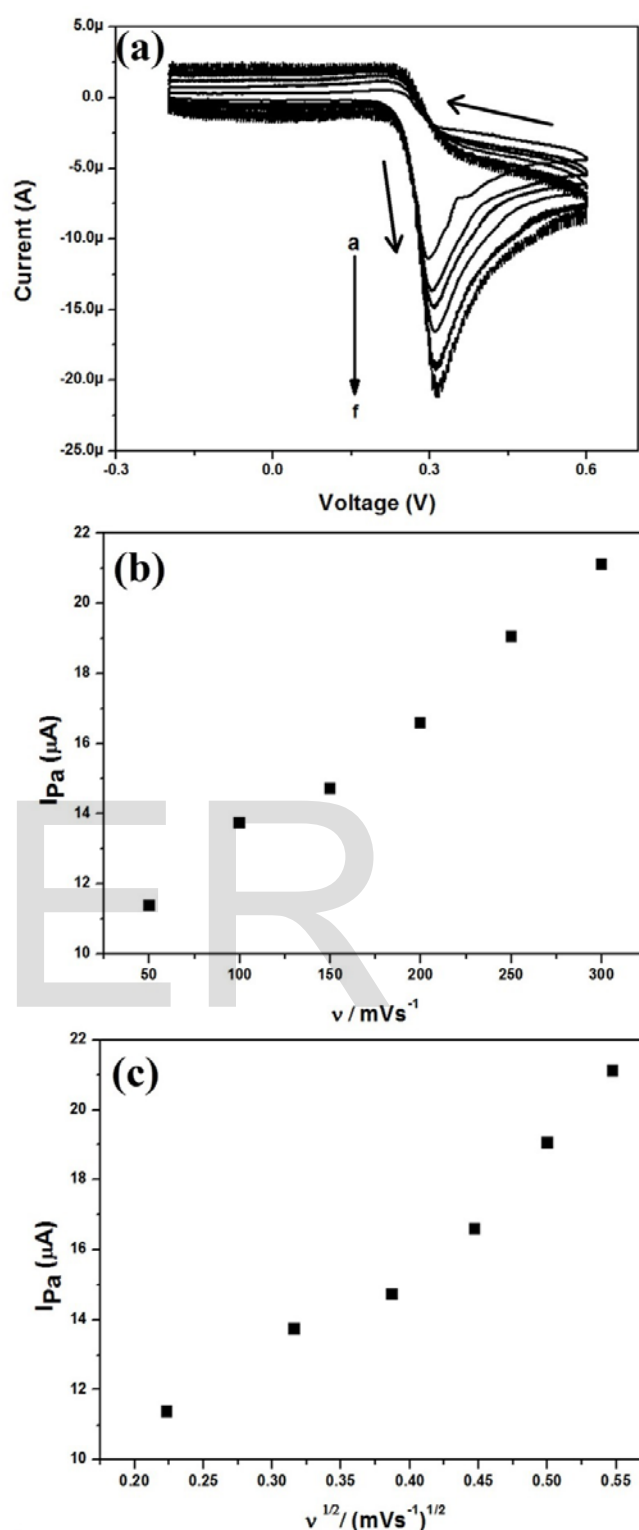


Fig. 11 (a) Cyclic voltammogram of 2mM UA at 50 to 300mVs^{-1} scan rate ($a=50$, $b=100$, ..., $f=300\text{mVs}^{-1}$) in PBS of pH 7.2 **(b)** Plot of anodic peak current vs. scan rate **(c)** Plot of anodic peak current vs. square root of scan rate

Cathodic peak current show very negligible increase in the current whereas cathodic peak potential do not show any po-

tential shift. Fig 11 (b) represents the plot of scan rate vs. anodic peak current of UA at 100mVs^{-1} in PBS of pH 7.2 and it varies from 11.37 to $21.11\mu\text{A}$ at a scan rate of 50 to 300mVs^{-1} . The correlation coefficient is found to be 0.9860 and this reveals the adsorption controlled electrode reactions. Fig. 11 (c) shows the plot of square root of scan rate vs. anodic peak current of 2mM UA and the correlation coefficient is found to be 0.9528 .

3.4.2 Effect of Concentration of Uric acid

Generally, the peak current increases with increase in analyte concentration [40]. Fig. 12 (a) represents the cyclic voltammogram of different UA concentration of 2mM to 2.5mM in PBS of pH 7.2 at 8mg YDMCPE.

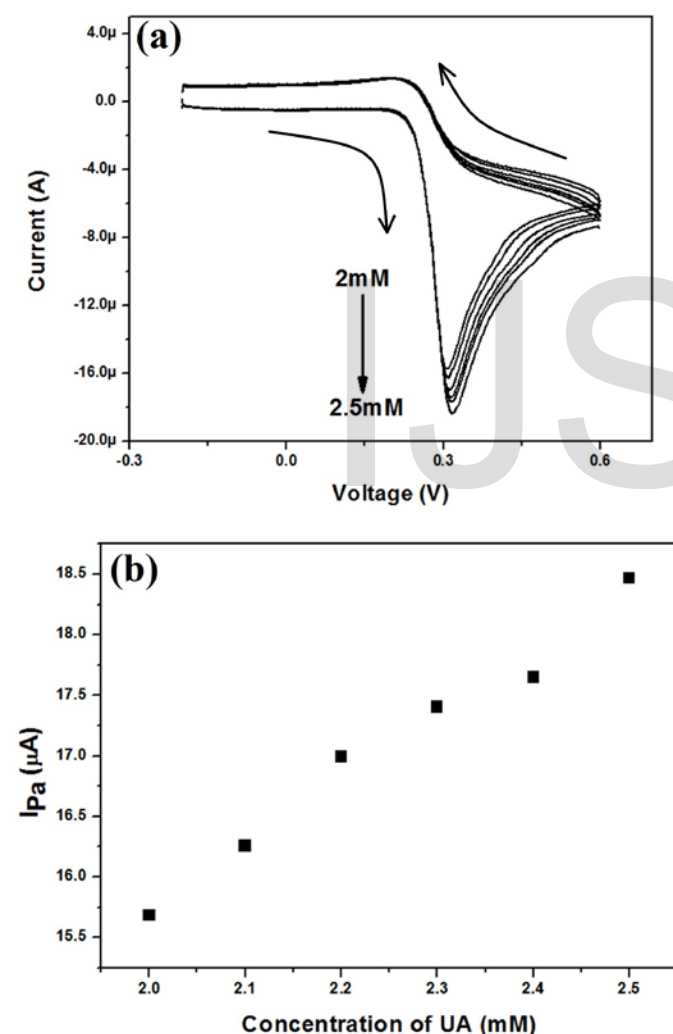


Fig. 12 (a) Cyclic voltammogram of 2 to 2.5mM concentration of UA at 100mVs^{-1} in PBS of pH 7.2 **(b)** Plot of anodic peak current vs. different concentration of UA

From the voltammogram it is evident that the anodic peak current increases linearly with increase in the concentration of UA at 100mVs^{-1} . The anodic peak current increases from

$15.68\mu\text{A}$ to $18.47\mu\text{A}$ at 2mM to 2.5mM UA concentration. Meanwhile the anodic peak potential shifts slightly towards the higher potential value. Oxidation potential at 2mM UA is 306mV and that at 2.5mM is 318mV . Cathodic peak current or cathodic peak potential of 2mM UA does not undergo any redox shift as shown in the voltammogram. The plot of anodic peak current vs. different concentrations of UA is as shown in the fig. 12 (b) and it depicts a linear relationship of anodic peak current and UA concentrations with correlation coefficient 0.9759 .

3.4.3 Effect of pH

Anodic peak potential of 2mM UA was studied successfully using 8mg YDMCPE at different pH values of PBS. Fig. 13 (a) represents the voltammogram of 2mM UA measured at different pH from 5.7 to 8 at a scan rate of 100mVs^{-1} .

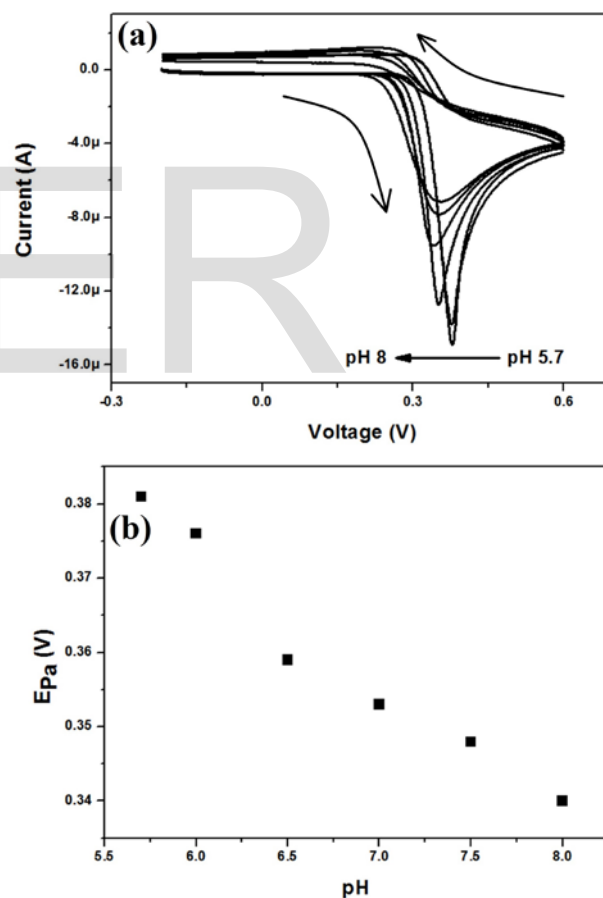


Fig. 13 (a) Cyclic voltammogram of 2mM UA at different pH of PBS buffer solutions at 100mVs^{-1} **(b)** Plot of anodic peak current vs. different pH from values 5.7 to 8

At higher pH, the anodic and cathodic peak potentials of 2mM UA shift towards the lower potential side due to the maximum redox rate. From the voltammogram it is evident that the an-

odic peak current decreases with increase in the pH values. Fig. 13 (b) represents the plot of different pH values of 0.2M PBS vs anodic peak potential of UA. The anodic peak potential of 2mM UA at pH 5.7 is 381mV and at pH 8 it decreases to 340mV. The plot shows the linear decrease in the anodic peak potential from pH 5.7 to 8 with correlation coefficient 0.9463.

4. Conclusion

The following conclusions can be made from the present investigation:

- Successfully prepared duplex stainless steel powder by DDPM milled for 10h and the powder was characterized through XRD, SEM and particle size analysis.
- The prepared powder was mixed with 1wt. % nano structured Y_2O_3 powder particles by turbula shaker mixture for 2h.
- 8mg YDMCPE show strong electro catalytic activity towards the oxidation of DA, AA and UA than DMCPE.
- YDMCPE can be used as sensor in medical field for the diagnosis of DA, AA and UA deficiency diseases.
- All the electrode reactions at the above bioactive compounds are adsorption controlled reactions.
- Although we reported very efficient YDMCPE as a sensor for detecting DA, AA and UA, there is still a need for further research to scale-up the issues.
- There is always a plenty of scope to fabricate sensitive, selective and material fouling resistant electrodes. YDMCPE satisfy the above needs with excellent performance.

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