Corrosion Studies of Copper Electrodes in Acidic Medium in the Presence of N,N-Dimethylaniline

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Abstract

In this work, the influence of N,N-dimethylaniline (DMA) as inhibition agent for copper corrosion process has been studied. The electrochemical behaviour of DMA on platinum and copper electrodes in acid solutions has been analyzed by cyclic voltammetry. Inhibitory properties of DMA for copper corrosion protection were studied in 0.5 M H_2SO_4 solutions in the presence of different concentrations of inhibitor 10^{-6} M and 10^{-3} M, respectively. The morphology of copper samples obtained in the absence and presence of DMA has been studied by scanning electron microscopy (SEM).

Introduction

The possibility of the copper corrosion prevention using mostly organic inhibitors has attracted many researchers. The most widely used inhibitors are organic derivatives such as azoles [1,2], amines [3,4], amino acids [5] and many others. The presence of nitrogen heteroatoms in organic compounds like amines improves its action as copper corrosion inhibitor [6]. The aim of this study was to investigate the inhibitory effect of N,N-dimethylaniline (DMA) in 0.5 M H_2SO_4 at room temperature using cyclic voltammetry and linear polarization.

Experimental

The chemicals used for this study *i.e.*, sulphuric acid (H_2SO_4) and N,N-dimethylaniline (DMA, $(CH_3)_2NC_6H_5$) (analytical grade) were purchased from Merck Company (Germany). The distilled water was used for all experiments. Inhibitory properties of DMA for copper corrosion protection were studied in 0.5 M H_2SO_4 solutions in the presence of different concentrations of inhibitor 10^{-6} M and 10^{-3} M, respectively. Cyclic voltammetry, linear polarization method (Tafel curves) and scanning electron microscopy (SEM) were carried out to observe the inhibition effect of copper corrosion process.

Results and discussion

The electrochemical behaviour of DMA on platinum electrode at different scan rates was investigated by cyclic voltammetry measurements. Figure 1 shows cyclic voltamogramms recorded in 0.5 M H_2SO_4 and in the presence of 10^{-3} M DMA at different polarization rate between 10 ÷ 500 mV s^{-1}.

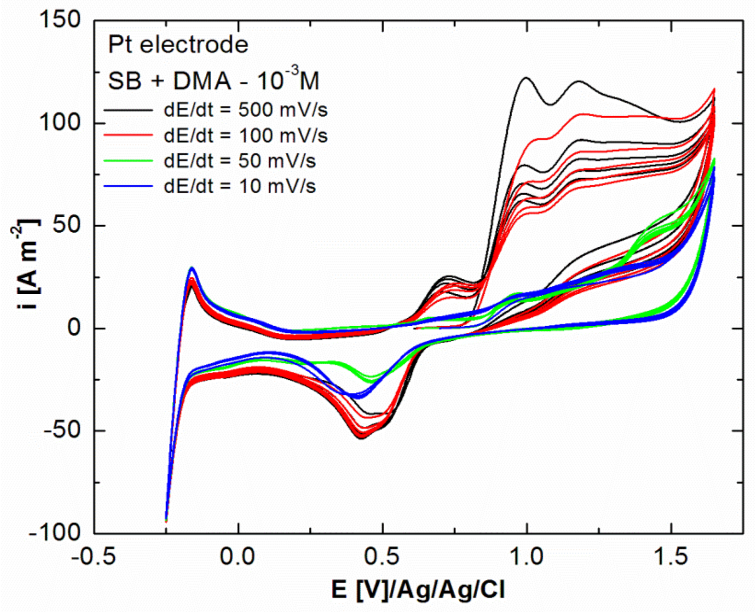


Figure 1. Cyclic voltammograms (5 cycles) recorded on Pt in 0.5 M H_2SO_4 and in the presence of 10^{-3} M DMA at different scan rates.

In order to study the DMA influence on the anodic or cathodic process on copper electrode, cyclic voltammograms were recorded in 0.5 M H_2SO_4 in the absence and presence of 10^{-3} M DMA at 500 mV s^{-1} polarization rate, which are presented in Figure 2.

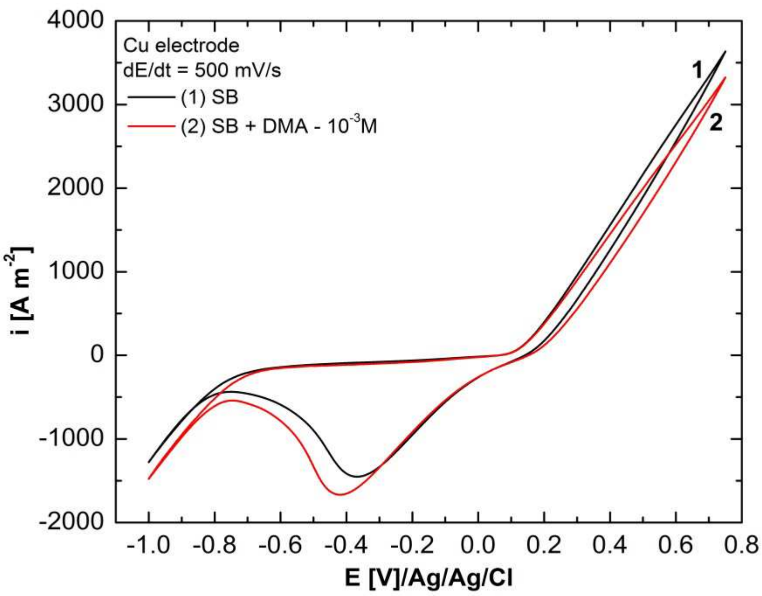


Figure 2. Cyclic voltammograms recorded on copper electrode in 0.5 M H_2SO_4 (1) and in the presence of 10^{-3}M DMA (2), scan rate 500 mV s^{-1}.

The inhibition effect of different concentrations of DMA on copper corrosion process was studied by Tafel polarization method. Figure 3 shows the Tafel polarization curves recorded on copper electrode in 0.5 M H_2SO_4 and in the presence of 10^{-6} and 10^{-3} M DMA at two polarization rates.

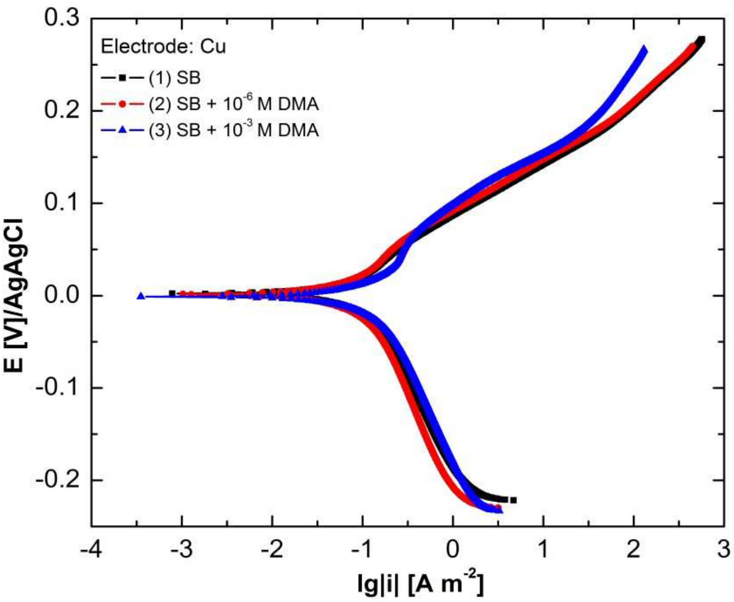


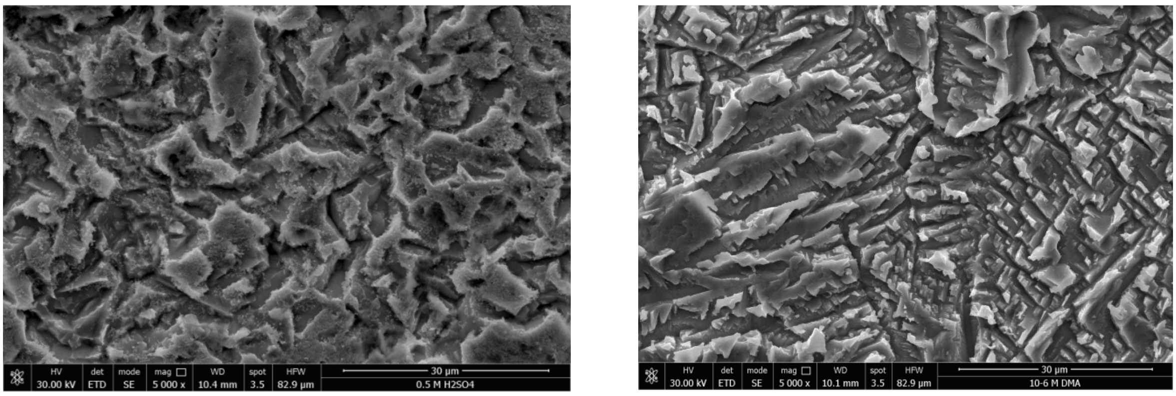
Figure 3. Tafel polarization diagramms recorded on copper electrode (dE/dt = 2 mV s^{-1}) in 0.5 M H_2SO_4 without and with different concentrations of DMA.

The obtained polarization parameters, *i.e.*, corrosion current density (i_{cor}), corrosion potential (E_{cor}), anodic Tafel slope (b_a), cathodic Tafel slope (b_c), polarization resistance (R_p) and corrosion rate (v_{cor}) are gathered in Table 1.

Table 1. Polarization parameters for the corrosion of copper in 0.5 M H_2SO_4 in the absence/presence of different concentrations of DMA.

Inh. conc., M	i_{cor}, µA cm^{-2}	E_{cor}, mV	$-b_c$, mV dec^{-1}	b_a, mV dec^{-1}	R_p, Ω	v_{cor}, mm $year^{-1}$
BS	7.84	2.01	201.4	64.5	2435	0.36
10^{-6}	5.23	1.25	225.1	70.8	3506	0.24
10^{-3}	4.75	-5.04	205.4	82.5	4758	0.21

The surface morphology of copper samples was analysed after a corrosive attack in the presence and absence of 10^{-6} M DMA during 240 h immersion time. Figure 4 shows SEM images recorded for copper samples.



(a) (b)

Figure 4. SEM images of copper samples after 240 h immersion time in 0.5 M H_2SO_4 (a) and 10^{-6} M DMA (b).

Conclusions

The obtained results confirm that DMA has promising corrosion inhibition properties for copper in acidic environment. Further studies will be required to determine the weight loss data by gravimetric method in the absence and presence of different amounts of DMA, thereby the inhibition efficiency and surface coverage will be calculated. Also, the inhibition effect of DMA on copper corrosion process at different temperatures (308, 318, 328, 338 K) will be investigated in the future.

Acknowledgements

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