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Preparation of triazole compounds via click chemistry reaction and formation of the protective self-assembled membrane against copper corrosion

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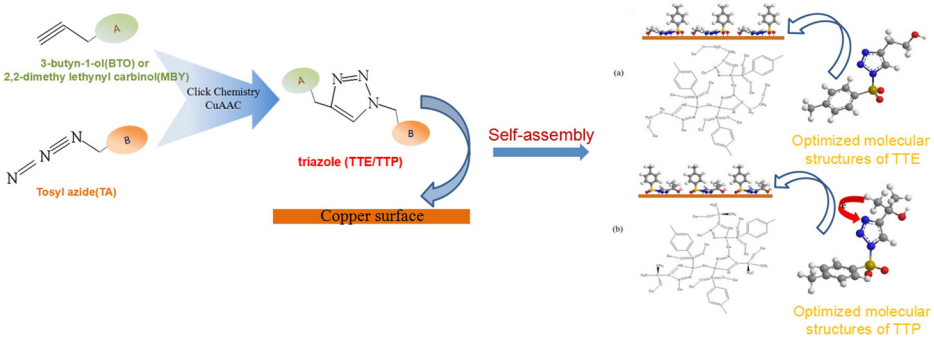
GRAPHICAL ABSTRACT



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ABSTRACT

The triazole inhibitors of 2-(1-tosyl-1H-1,2,3-triazol-4-yl)-ethanol (TTE) and 2-(1-tosyl-1H-1,2,3-triazol-4-yl)-propan-2-ol (TTP) were synthesized via the click chemistry reaction. Self-assembling technique was used to form self-assembled membrane (SAM) of TTE and TTP on copper surface. The electrochemical measurement results indicate that the TTE and TTP film can strongly suppress copper corrosion in 3 wt.% NaCl solution and the inhibition efficiency of TTE and TTP are 89.4% and 93.1%, respectively. TTP shows better inhibition performance than TTE. Polarization curves show that TTE and TTP predominantly retard the anodic process of the corrosion reaction. The results of quantum chemical calculations and molecule dynamics (MD) simulations reveal that the formation of TTE and TTP SAM on copper surface is mainly achieved by the adsorption of triazole ring and O atoms at horizontal orientation.

1. Introduction

Over the past several years, click chemistry has received much attention and become one of the most powerful tools in synthesis, surface modification, bioconjugation, material science, polymer functionalization, drug development and many other areas [1–7]. As one of

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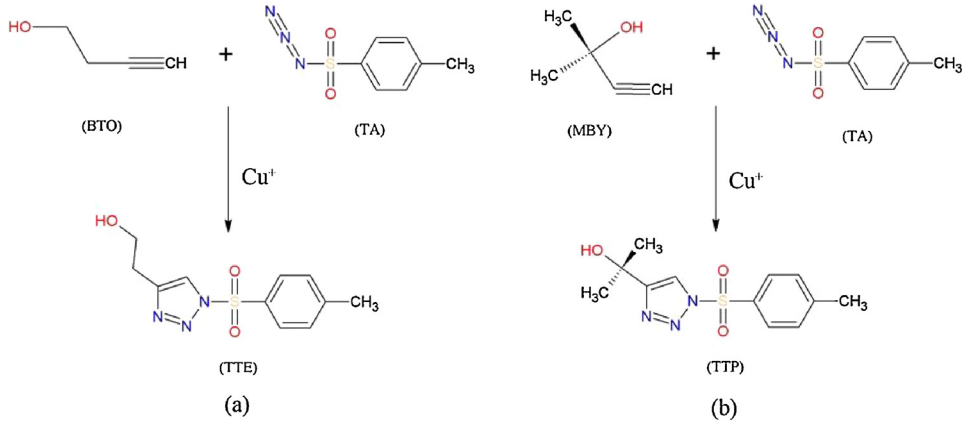

Fig. 1. The click chemistry reaction equation of BTO and TA (a); MBY and TA (b).

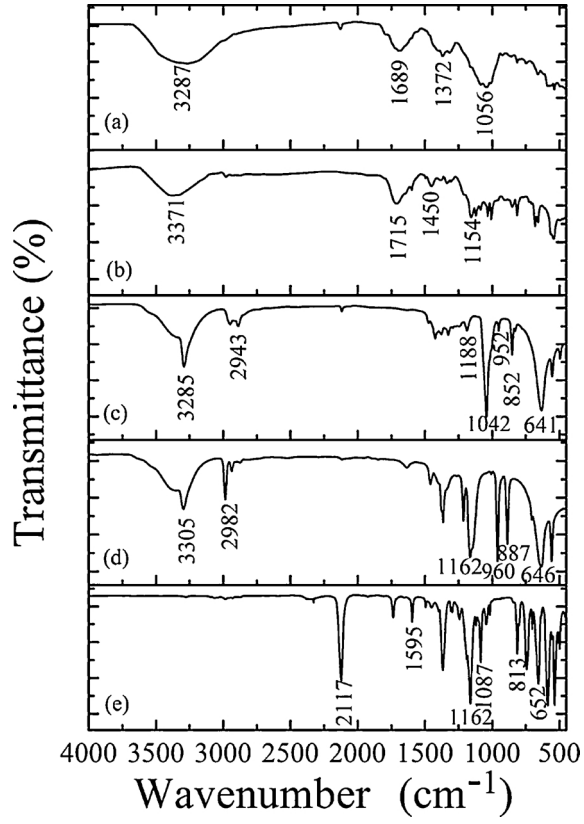

Fig. 2. FTIR spectra of compounds in click chemistry reaction: (a) TTE; (b) TTP; (c) BTO; (d) MBY; (e) TA.

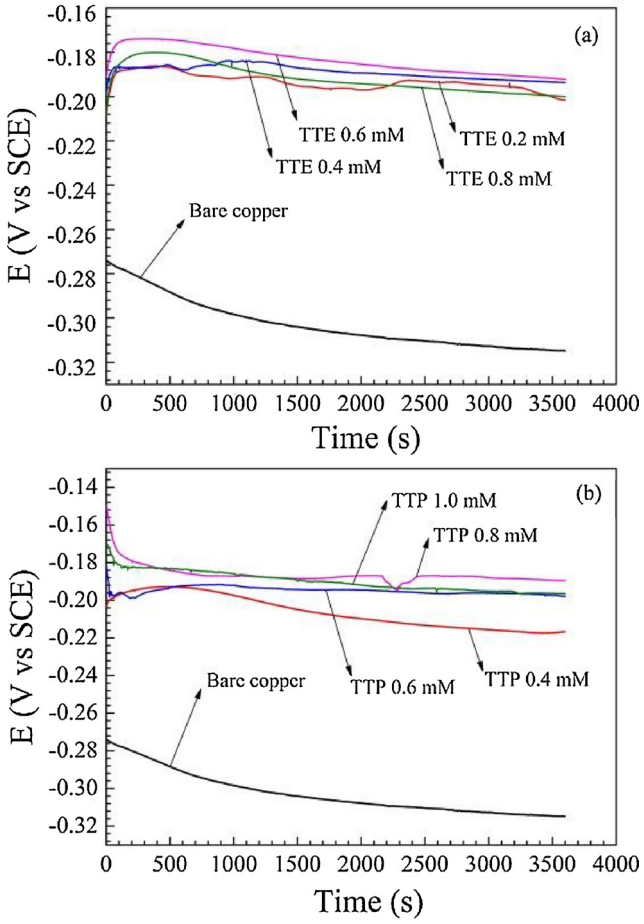

Fig. 3. Variation of OCP with immersion time for copper electrode with and without SAM in 3 wt.% NaCl solution at 25 °C: (a) TTE; (b) TTP.

the classical click reactions to date, Cu(I)-catalyzed 1,3-dipolar cycloaddition reaction (Cue-AAC) based on the synthesis of 1,4-Disubstituted 1,2,3-Triazoles between azides and terminal alkynes has exhibited remarkable broad applications in various areas due to its high yield, exquisite selectivity, simple reaction and purification conditions [8–11].1,2,3-Triazoles can be extensively used as the subject to attain better properties in considerable research such as corrosion protection, coatings, polymers, biomedical applications, and so on [12–15]. For corrosion applications, the inhibition property of triazole and its derivatives have been reported frequently in recent years [16–20]. Our group is engaged in the development of inhibitors and coatings on metal surface. Enlightened by these, we have coined “click assembly” philosophy and assembled triazole inhibitor films on copper surface by utilizing in-situ produced Cu(I) as the catalyst, resulting from copper corroded by 3 wt.% NaCl solution. The click-assembled triazole film could strongly suppress the corrosion reaction of copper in 3 wt.% NaCl and exhibited high protection efficiency [21,22].

To investigate the corrosion inhibition performance of the click-synthesized triazole compounds, herein we synthesize two types of triazole inhibitors of TTE and TTP via the click chemistry reaction. The inhibitors were then assembled to form SAM on copper surface via self-assembled technique. The click chemistry reaction equations between 3-butyn-1-ol (BTO) and tosyl azide (TA), 2,2-dimethy lethynyl carbinol (MBY) and tosyl azide (TA) are shown in Fig. 1(a) and (b), respectively. The protection of the SAM against copper corrosion was evaluated by the electrochemical impedance spectroscopy (EIS) and the