4,5-Dinitrobenzimidazole and 5-nitrobenzimidazole adsorption on copper surface. Electrochemical and XPS study*

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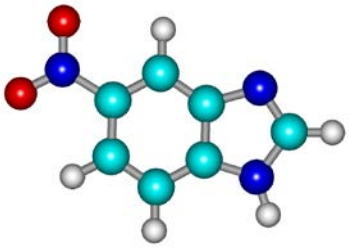
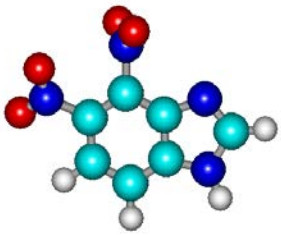
As many constructional metals copper suffers from corrosion in aqueous solutions and therefore it needs protection. One of the most effective protection methods is usage of corrosion inhibitors, often organic compounds. For copper - azoles and their derivatives are especially interesting.

Rather effective ones are believed to be 4,5-dinitrobenzimidazole and 5-nitrobenzimidazole, whose structures are shown below.



5-nitrobenzimidazole



4,5-dinitrobenzimidazole

In the present study using XPS and electrochemistry we have investigated the mentioned substances when they adsorbed on copper samples in neutral borate buffer (pH 7.4) with and without 0.5M NaCl. XPS analysis of copper samples shows that both inhibitors adsorb on the surface and remain there even after thorough ultrasonic washing. It is evidenced by the presence of two N1s peaks, one for $-NO_2$ group (406.1 eV) and another for -N- in azole group (399.8 eV) with expected different peak intensities. When adsorbed, the N1s azole peak shifts from the peak position observed for azole powder (400.5 eV). At the same time, the peak width (2.39 eV) decreases in comparison with azole powder (2.62 eV). It may result from deprotonation of azole nitrogen atom, equalization of the charges on them and their coordination with Cu^+ ions. The Cu2p3 spectrum reveals the only peak at 932.8 eV witnessing the absence of Cu^{++}. The Auger spectra $CuL_3M_{45}M_{45}$ electrons may be deconvoluted into three individual curves assigned to Cu^0 (568 eV) , Cu_2O (570 eV) and complex CuL_2, where L - inhibitor molecule. The maximum at 572.5 eV of the third component belongs to this copper -inhibitor complex due to formation Cu-N bonding. According to interpretation of XPS data 5-nitrobenzimidazole and 4,5-dinitrobenzimidazole form polymolecular complex film which thickness increases in time of exposure and can reach 9 nm in several hours.

Potentiodynamic curves of the copper electrode have shown gradual decreasing the anodic current upon addition the substances under study in pure borate buffer containing 0.01M NaCl and in 0.5M NaCl solution. Corrosion protection effect of 5-nitrobenzimidazole and 4,5-dinitrobenzimidazole is compared and discussed.

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