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Antibacterial Property of the Chemically Adsorbed Monolayer Functionalized With Imidazole-Copper Complex

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Abstract - Epoxy-terminated chemically adsorbed monolayer (CAM) was prepared with 11,12-epoxydodeclytrimethoxysilane(EDDS) on the substrates, followed by immersing the substrate modified with EDDS in the solution dissolved 2-methylimidazole for preparing the imidazole-terminated CAM. And then the substrate was immersed in $CuCl_2$ solution for preparing the chemically adsorbed antibacterial monolayer functionalized with an imidazole-copper complex. The samples were characterized by water contact angle measurements, Fourier transform infrared spectroscopy, and X-ray photoelectron spectroscopy. Additionally, antibacterial property of the sample was investigated against *Escherichia coli* in the antibacterial test. Despite their low copper content, the samples showed strong antibacterial effect against *Escherichia coli.*

As the ever-growing demand for healthy living, there is a keen interest in materials capable of killing harmful micro-organism. The conventional way of making antibacterial materials is to impregnate them with antibacterial agents, such as silver and copper ions. In this study, a monolayer functionalized with copper-imidazole complex was prepared on the substrate through the three processes described as follows. Si substrate was immersed in the toluene solution of 0.01 mol/L dissolved 11,12-epoxydodethlytrimethoxysilane (EDDS) for 2 hours in order to form the epoxy-terminated monolayer. After that, the sample was rinsed with chloroform, and was kept one day in the air atmosphere. The substrate modified with EDDS was immersed and reacted in the methanol solution of 0.01 mol/L of dissolved 2-methlyimidazole to prepare imidazole-terminated monolayer, and was cleaned by rinsing with chloroform and acetone in sequence. For coordinating Cu (II) ion process, the substrate modified with the imidazole-terminated monolayer was immersed in the $CuCl_2$ solution of 0.05 mol/L for 2h, thoroughly rinsed with a copious amount of deionized water.

A combination of the water contact angle measurements, FT-IR spectroscopy, UV-Vis spectroscopy and XPS spectroscopy was used for characterizing the samples. Moreover, antibacterial properties of the samples which are covered with the monolayers functionalized with copper-imidazole complex, were investigated against *E-coli*.

The formation of CAM functionalized with imidazole on the Si substrate was confirmed with the water contact angle measurements and FTIR spectra. With the XPS analysis,the existence of the Cu ions, which peak appears at 931eV, was confirmed. By the antibacterial test against *E.coli*, the sample inhibited the growth of bacteria for at least one week. As the Cu(II) ions are fixed through coordinate bonds similar to covalent bonds, the longer effect should be expected.

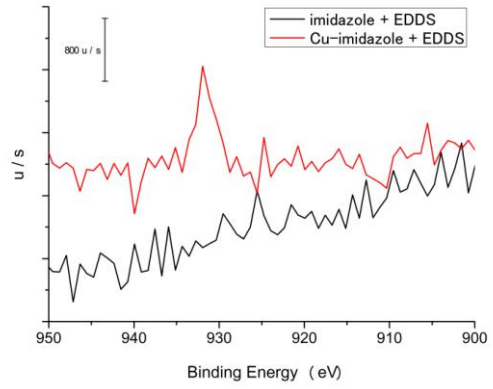
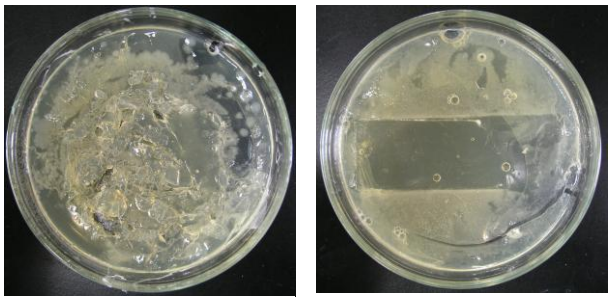


Figure 1: XPS spectra of monolayers functionalized with imidazole (red), and copper-imidazole complex (blue) on Si substrate.



(a) (b)

Figure 2: The agar media after removing the samples functionalized with imidazole (a) and copper-imidazole complex (b).