Coalescence of O/W emulsion by potential application

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An emulsion is a heterogeneous system composed of oil droplets suspending in water (O/W). It is metastable, being finally separated into the oil and the aqueous phases by coalescence. The instability is ascribed to an excess of the surface energy at the oil/water interface. The interfacial energy can be controlled by applying potential to the interface. Our idea is to monitor the coalescence of o/w emulsion including ferrocene as an electrochemical probe by means of a microscope and electrochemistry. An O/W emulsion was prepared by nitrobenzene including ferrocene was mixed vigorously with the sodium dodecylsulfate aqueous solution. An optical microscopic view showed oil spheres less than 7±0.1 μm in diameter. The emulsion was stable in a month without agitation. Fig.1 shows photograph of the O/W emulsion before (A) and after (B) applying potential at 1.0 V. The coalescence occurred after the potential application. Chronoamperometric current (Fig.2) showed large noises because of accidental coalescence. In order to relate the current with visualized coalescence, we took difference of digitized color codes on an image at time, t, from that at the time, $t - \Delta t$. Then variations of images can be expressed by the difference, as is shown in Fig.2B. The variation in A is related with that in B. We monitored the one oil droplet on the electrode surface by in situ electrochemical microscope and show the photographs, contact angles and currents as a function of potentials in Fig.3. No anodic wave was found in the domain from 0.0 V to 1.0 V even at 0.55 V at which ferrocene would be oxidized in nitrobenzene. We conclude that the coalescence is caused by the adsorption of oil droplets, formation of ferricenium ion, an increase in hydrophiricity of nitrobenzene, desorption of the surfactant, an increase in the surface energy, and leading to the coalescence.

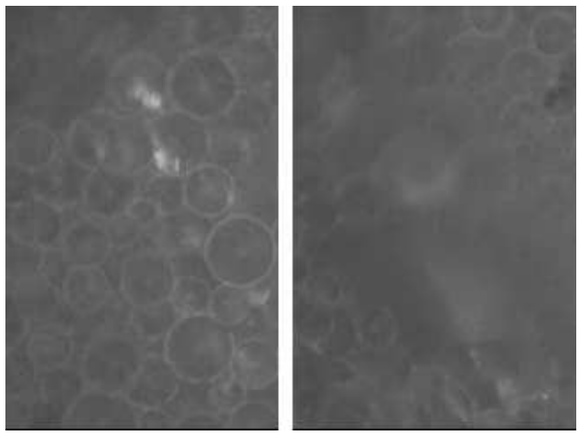

Fig.1. Photograph of O/W emulsion before (A) and after (B) applying potential at 1.0 V.

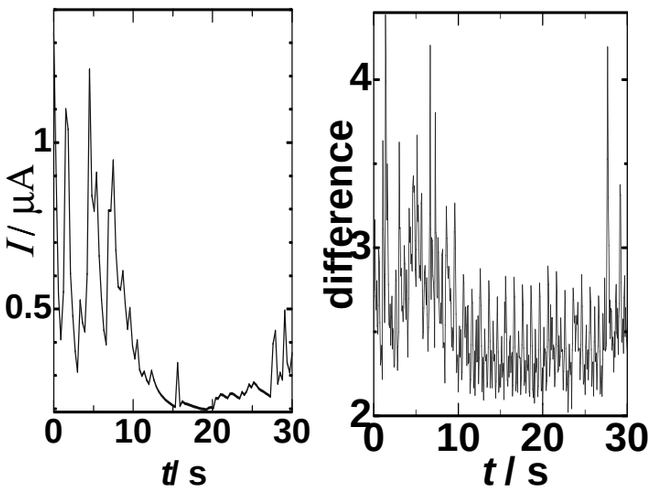

Fig.2. (A) is current-time curve at 1.0V. (B) is difference of digitized color codes on an image at time, t, from that at the time, $t - \Delta t$. The variation in A is related with that in B.

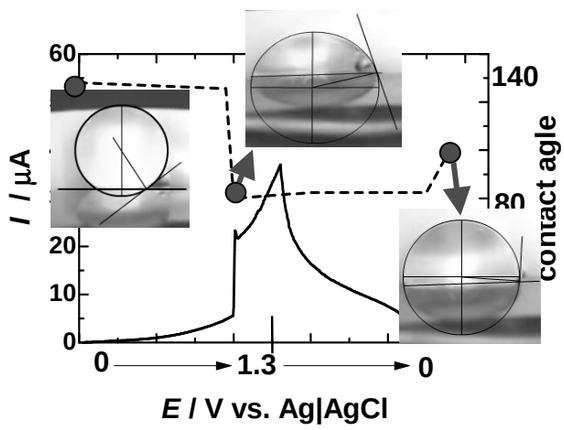

Fig. 3. Photographs, contact angles and currents as a function of potentials by monitored the one oil droplet on the electrode surface by means of in situ electrochemical microscope.

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