

Interaction of Acridine Orange Base with the ZnO Surfaces

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1 Introduction

Tetrathiafulvalene (TTF), a π -conjugated organic molecule, is a prototypical electron donor molecule in organic charge transfer salts. The molecule also exhibits an electron-donating character on the Au surface [1] and graphene [2]. Acridine orange base (AOB, Fig.1) is another π -conjugated molecule with an electron-donating character on the polycrystalline Au surface [3]. These molecules, however, behave differently on the ZnO surfaces; our recent study shows that charge is transferred from the adsorbed AOB layer to single crystal ZnO surfaces, whereas TTF acts as an electron acceptor on the ZnO surfaces [3].

Analysis of TTF adsorption state on the ZnO surfaces reveals that not all of adsorbed TTF acts as an electron acceptor but a fraction of TTF do [3]. A part of TTF is in a neutral state, while decomposition species are also formed on the surfaces at room temperature. Decomposed species donate some amount of charge to ZnO so that the net charge transfer between the adsorbed TTF layer and the ZnO surface is determined by the ratio of anionized TTF to decomposed TTF.

In order to understand the charge transfer mechanism between AOB and ZnO, it is crucial as a first step to know how AOB interacts with the ZnO surfaces. In the present study, we have investigated the adsorption state of AOB on three ZnO surfaces, i.e. ZnO(10-10), (0001) and (000-1), by photoelectron spectroscopy (PES) and x-ray absorption spectroscopy (XAS).

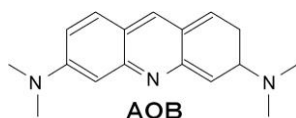


Fig. 1 Molecular formula of acridine orange base (AOB).

2 Experiment

AOB was purified by sublimation at 120°C under the flow of N₂ before use. AOB was then deposited on the ZnO surfaces by using a home-built evaporator under the ultrahigh vacuum condition. The substrate surfaces were kept at room temperature during AOB deposition. The AOB-adsorbed ZnO surfaces were subjected to the PES and XAS measurements at BL-13A immediately after deposition.

3 Results and Discussion

Because of the high reactivity of the surface O atoms toward TTF, the amount of dissociated TTF is proportional to the density of the O atoms on the ZnO

surfaces [3]. Contrastingly, dissociation of AOB is limited on ZnO. The C 1s spectra of adsorbed AOB have a double-peaked lineshape (Fig. 2). The one at the lower binding energy side is associated with the C atoms in the C-C bonds, whereas the C atoms in the C-N bonds contribute to the peak at the higher binding energy side. Lineshape analyses of the C 1s spectra, as well as the N 1s spectra, reveal that the amount of decomposed AOB is less than 20% of the total amount of adsorbed AOB irrespective of the surface orientation. It is thus concluded that charge is transferred from AOB in a molecularly adsorbed state to the ZnO surfaces.

Acknowledgement

Financial support from Asahi Glass Foundation is appreciated.

References

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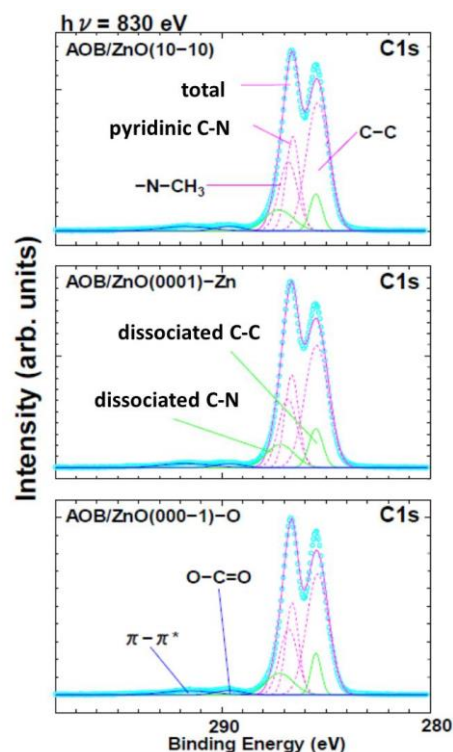


Fig. 2 C 1s spectra of AOB on the ZnO surfaces. The spectra are decomposed into seven contributions using Gaussian functions.