B-AD-025

Characterization of surface properties of carbon black by temperature programmed desorption (TPD)

The evaluation of functional groups and edges on the surface of carbon black is important for material design. Oxygen-containing surface functional groups are particularly important and have a significant impact on catalytic performance, electrochemical properties, etc. For this study, GCB (graphitized carbon black: #3845) and CB (carbon black: #51) were analyzed in a BelCat II chemisorption analyzer, employing temperature-programmed desorption (TPD.) Samples were heated to elevated temperatures under an inert gas flow, which caused the surface oxygen-containing functional groups to decompose and desorb from the surface. At the end of this process, the surface was then quantified by detecting H_2O, H_2, CO, and CO_2. For the measurement, approximately 1g of each carbon black was heated and desorbed from 50°C to 1000°C under He gas flow, and the desorbed gas spectrum was evaluated using the system's TCD and a quadrupole mass spectrometer (BELMassII.)

Figures 1 and 2 show the results of desorption spectra (desorbed gas analysis) of GCB and CB; it can be inferred that a small amount of H_2O, CO, CO_2 etc. remain on the edge surface of GCB, even though it is pretreated at 3000 K. The surface of CB is not homogeneous. On the other hand, CB has 25 to 100 times more of each component than GCB, which means that many functional groups remain and the surface is non-uniform. Each result is summarized in Table 1 (number of each molecule per unit area). Values obtained are in good agreement with the references[*1] for the relationship between desorption temperature and oxygen-containing functional groups of various carbons shown in the bottom of each figure.

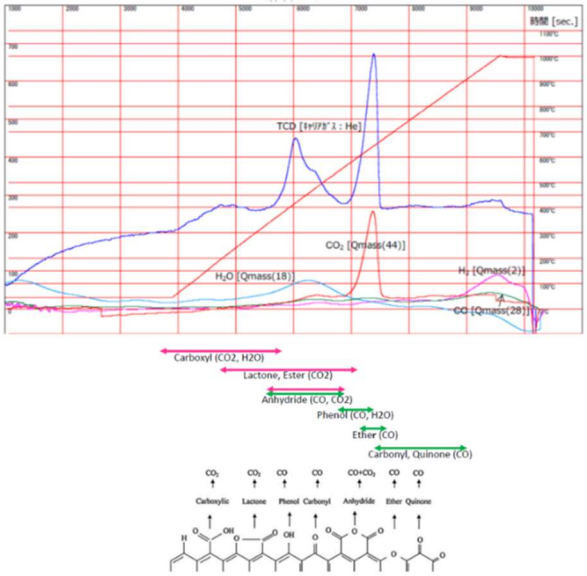

Fig. 1 Evaluation of TPD spectrum of GCB (TCD/Q-mass)

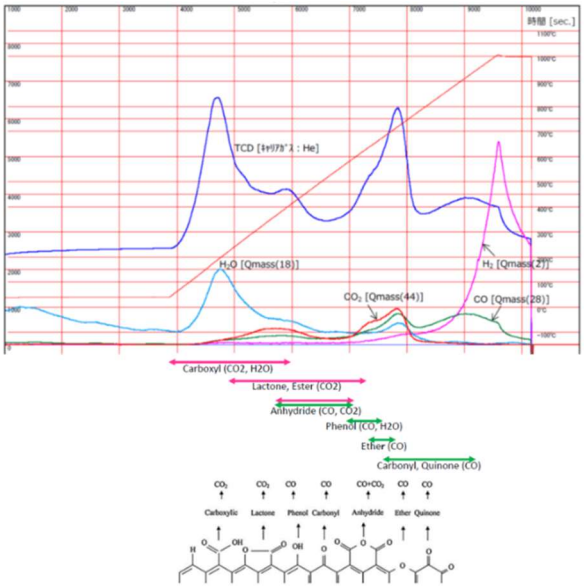

Fig. 2 Evaluation of TPD spectrum of CB (TCD/Q-mass)

Carrier gas: He (99.999%) 30cc min^{-1}

Temperature 50℃ to 1000℃ (temperature rise rate: 10℃ min^{-1}, holding time: 10 min)

Detectors TCD/Q-mass

Table 1 Number of each molecule (per area) obtained from TPD spectra of GCB and CB

	H_2 / molecules nm^{-2}	H_2O/ molecules nm^{-2}	CO/ molecules nm^{-2}	CO_2/ molecules nm^{-2}
GCB (#3845)	0.03	0.08	0.06	0.06
CB (#51)	3.2	4.8	2.8	1.5

These TPD results are in good agreement with the α_s-curves of GCB and CB and the surface characterization from differential heat of adsorption in Application Document B-AD-019

*1 Reference: Hideyuki Takagi, Carbon (No.237) *in Japanese*, p.67-71

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