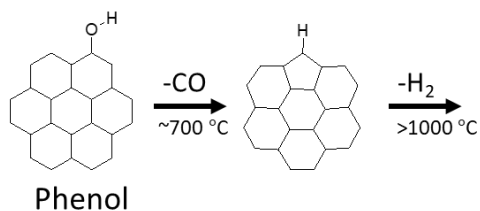


## An analysis of chemical structure of carbon edge sites by using deuterium-labeling temperature-programmed desorption technique

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Temperature programmed desorption (TPD) technique has been used for the qualitative and quantitative determination of oxygen-containing functional groups formed on the edges of carbon materials. It is known that phenol (-OH) and ether (-O-) could not be qualitatively determined by TPD technique. These two kinds of functional groups thermally decompose as CO at around 600 to 700 °C, but their decomposition temperatures and decomposition gases are the same, so they cannot be distinguished by TPD technique. Since phenol-group contains hydrogen in its chemical structure, as shown in **Figure 1**, it is thermally decomposed as CO, and then heated further to produce H<sub>2</sub>. By phenol hydrogen being labeled with D<sub>2</sub>O, hydrogen derived from the labeled phenol could be detected and separated as DH and D<sub>2</sub> in TPD spectra. With this labeling method, the chemical structure of edge sites including phenol/ether could be specified accurately. In this study, we tried to identify the chemical structure of carbon edge sites by using the deuterium-labeling TPD technique. Deuterium species (D<sub>2</sub>O, DHO, D<sub>2</sub> and DH) were desorbed from deuterium-labeled carbon samples in the TPD run. Analyzing the obtained TPD enables to distinguish the chemical structures attaching to the edge sites of graphitic layers, phenolic group, ether group and hydrogen atoms, which are unsolved in the conventional TPD technique. This labeling method makes it possible to identify the chemical structure of the edge sites in more detail.



**Figure 1.** Schematic images of thermal decomposition of phenol.