# Lewis Base Properties of Potassium-Graphite

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*Summary* Potassium–graphite ($C_8K$) reacts with weak protic acids such as water and alcohols predominantly by an acid–base reaction with only small amounts of hydrogen evolution to yield a partially reduced graphite as shown by E.S.C.A. spectroscopy.

GRAPHITE forms a wide assortment of intercalation compounds in which various substrates are inserted between the planes of the carbon atoms, including those with the alkali metal such as potassium–graphite,[1] which is of interest both as a polymerization catalyst and because of its resemblence to Group 8 metals in hydrogenation, hydrogen–deuterium exchange, and Fischer–Tropsch reactions.[2] We describe here some details of the chemistry of potassium–graphite, namely its Lewis base character, which are relevant both to its catalytic chemistry and to its reactions as a stoicheiometric reagent. Specifically, we report that $C_8K$ reacts with weak protic acids such as water and alcohols predominantly by proton abstraction to give a partially reduced graphite and potassium hydroxide and not by reduction leading to hydrogen evolution.

Potassium–graphite ($C_8K$) is easily prepared from potassium and graphite by the procedure of Lalancette.[3] When water or some other proton source such as an alcohol is added to a tetrahydrofuran (THF) suspension of the gold coloured $C_8K$, an exothermic reaction ensues, which could be represented by either reaction (1) or reaction (2). According to the stoicheiometry of reaction (1), 0·5 mole of

$$2C_8K + 2H_2O \rightarrow \text{graphite} + 2KOH + H_2 \qquad (1)$$

$$C_8K + H_2O \rightarrow C_8H + KOH \qquad (2)$$

hydrogen will be evolved per mole of $C_8K$ upon addition of water while none will be evolved in reaction (2). The experimental observation that addition of water leads to evolution of only 0·01—0·05 mole of hydrogen per mole of $C_8K$ or 0·01—0·08 mole of hydrogen per mole of water if an excess of water is used suggests that reaction (1) is comparatively unimportant. The predominant reaction is the simple acid–base reaction (2) leading to a partially hydrogenated graphite. In fact, the small amount of hydrogen evolution appears to be due to unchanged potassium metal from the preparation of $C_8K$ rather than reaction (1), although reaction (1) cannot be excluded.[4] These results are in contrast to the known reactivity of potassium and water; they agree with the known reactivity of sodium napthalide and water.[5] Our conclusions about the importance of reaction (2) are further supported by separate experiments which show that under our conditions (atmospheric pressure, 25 °C, THF solution), $C_8K$ will not absorb hydrogen. Additional evidence that hydrogen is not being 'trapped' by the graphite includes the observation that the amount of hydrogen evolved rapidly reaches an equilibrium value which does not change over a 24 h period. However, $C_8K$ does adsorb hydrogen under other conditions to form ternary graphite–potassium–hydrogen intercalation compounds.[6]

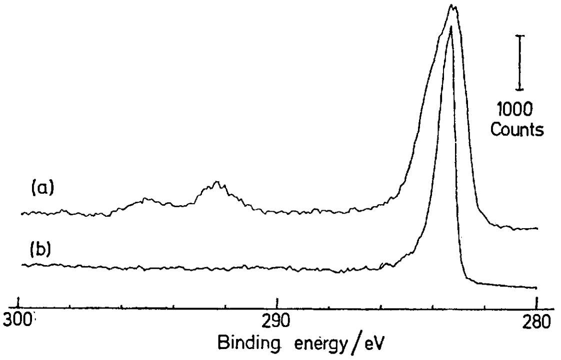

FIGURE. (a) E.S.C.A. spectrum of $C_8K$ after reaction with water. The smaller peaks at 294 and 296 eV are due to potassium hydroxide; (b) E.S.C.A. spectrum of starting graphite.

The product of reaction of $C_8K$ with water in an acid–base reaction such as reaction (**2**) would be a reduced graphite with a disrupted aromatic system and *ca.* 10% hydrogen. Visual examination of this reduced graphite shows some minor physical differences such as smaller particle size, reduced lustre, and readier combustion. E.S.C.A. studies of the graphite produced reveal changes in the chemical structure from that of the starting graphite (Figure). Comparison of the carbon 1*s* peak of the starting graphite and of the reduced graphite shows a much broader carbon peak for the latter, indicative of the presence of more than one type of carbon atom as would be expected for a partially reduced graphite.

We thank the Donors of the Petroleum Research Fund, administered by the American Chemical Society, and the Robert A. Welch Foundation for support. The Hewlett–Packard 5950A E.S.C.A. spectrometer used in this work was purchased with the aid of an N.S.F. grant to Texas A&M University.

(*Received*, 29*th July* 1976; *Com.* 871.)

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