# IBS Center for Multidimensional Carbon Materials

Special Guest Speaker


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### Proton and Proton/Electron Mixed Conducting Properties of Graphene Oxide

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**2 P.M.**

Bldg. 101
Seminar room on the 1st floor

Graphene oxide (GO) can be synthesized by easy method at low cost. GO possesses excellent mechanical strength, flexibility and high surface area. Therefore, researcher worldwide are trying to adopt GO for various applications. GO has chemically different regions such as hydrophobic p-conjugated $sp^2$ domains with electric conduction and hydrophilic $sp^3$ domains with proton conduction. Moreover, the ratio of this region can be tuned easily through varying in the method and extent of reduction. Thus GO can be adopted for specific applications. GO has been applied in a wide range of electrochemical energy generating systems including fuel cells, supercapacitors, lithium-ion batteries and so on. In fact, reduced GO (rGO) with high electric conductivity and surface area is suitable for electrodes, while GO with high proton conductivity and perfect gas barrier property is suitable for electrolyte. In this talk, we describe about the proton and proton/electron mixed conducting properties of GO.

Proton conduction plays important role in a wide range of electrochemical systems such as fuel cells and supercapacitors. Usually, proton conductors are constructed by a strong framework for maintaining the structure and proton transfer channel with hydrophilic property. From this perspective, GO with carbon framework and oxygen functional groups should act as a proton conductor. Based on this issue, we measured the proton conductivity of GO and found it was relatively high at 100% humidity, nearly $10^{-3}$ S/cm. The activation energy ($E_a$) of proton transfer was found to be low (< 0.3 eV) through measuring the slope of Arrhenius plot. The low $E_a$ value implies that proton conduction in GO proceeds via the Grotthuss mechanism, where the protons move by hopping from an $H_3O^+$ ion to the nearest water molecule.

Materials with relatively high electric and protonic conductivities (mixed conductor) are important for various applications such as fuel cells, supercapacitors and gas separation membranes. It is well-known that the electric conductivity of GO dramatically increased by reduction processes. On the other hand, the proton conductivity decreased by a reduction process because oxygen functional groups and layer distance of GO decrease through reduction. Therefore, proton and electron conducting in rGO should be easily produced by an optimized reduction process. Through controlled reduction of GO by UV irradiation and thermal annealing, we has found the suitable degree of reduction for obtaining an optimized mixed conductor. Moreover, both conductivities were successfully enhanced by introducing sulfate ions into the rGO interlayers.

***You are cordially invited to attend!***