Nanomaterials synthesized by Solution Plasma

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Solution plasma (SP) is one of non-thermal plasma in liquid phase. SP provides us selective reactions in reactants molecules in organic and aqueous solution, eg., C-H activation linking with cyclic organics, reduction reactions for transition metals complex. In these reactions, the primary reaction pathway is charge transfers (CTs) at the interface of plasma and solution, not the reactions in plasma. The reaction pathway from occupied molecular orbitals (MOs) of reactants to plasma and from plasma to un-occupied MOs. The CTs reactions produce the cation radicals in the solution. For examples, water cation radicals and benzene cation radicals were seen in aqueous and benzene solutions, respectively. The reaction selectivity is determined by the comparisons of the wall potential at the solution and plasma and the occupied and un-occupied MOs of reactants. Thus we can design the reactions and products induced by SP.

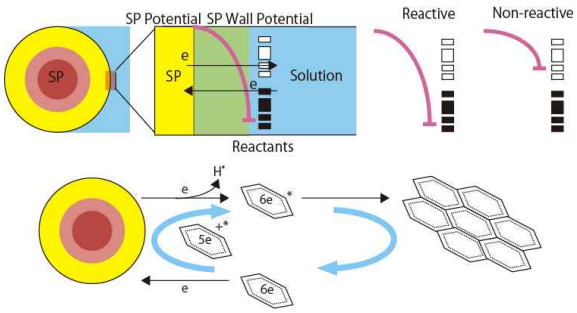

Fig.1 SP reaction mechanism for organics

We has been already successful to synthesize the hetero-graphene, some organic complex embedded graphene, reduced molecular weight natural products, CNT with function head groups through amide bonds formation transition metal oxides sheet, metal clusters (less than 2 nm), core-shell metal nanoparticles, and etc..

In this presentation, we show the SP reaction design and synthesis from organic molecules to several types of hetero-graphene. For an example, I showed 18-crown-6-ether embedded graphene synthesized from benzene and 18-crown-6-ether solution by SP. the Raman Shift and TEM images of hetero-graphene synthesized from a-e organic molecules in organic solutions. Fig.1 show the reactions and TEM images, SEAD pattern, and STM image. TEM images and SAED pattern indicate the several layers stacked graphene. ABAB stacking slightly rotate around [002] direction. STM images showed the presence of holes in graphene sheets.

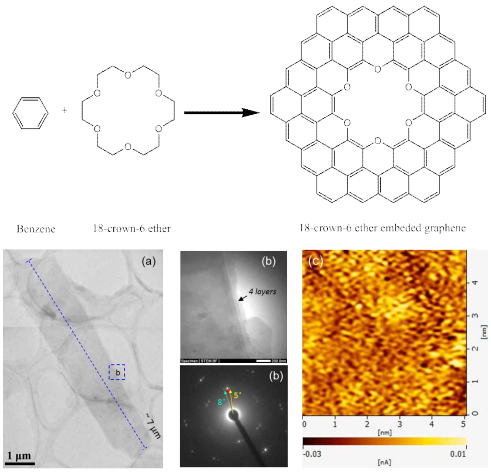

Fig.2 18-crown-ether embedded graphene (a)TEM images, (b) HRTEM images and SEAD pattern, and (c) STM image

Acknowledgments
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