Solution Plasma Catalyst and the Reactions

Nagahiro Saito [1], Sang-Woo Chae [1], Kyu-Sung Kim [1], Yukihiro Muta [1], and Maria Antoaneta Bratescu [1]

[1]Nagoya University, Japan

Solution plasma (SP) is one of non-thermal plasma in liquid phase. SP provides us a kind of catalyst role. The energy levels of SP corresponds to ca. 1 eV for electron donor level and ca. 7 eV for electron acceptor level. The energy levels are related to the electron energy in plasma and plasma potential. Thus the energy levels are identified by plasma and solution.

This band gap energy, 6 eV, is closer to AlN, which is ultraviolet light around the wavelength of 200 nm. Thus these electron transfers on the energy levels are equal to the photocatalyst on the semiconductor with wide band gap and the insulator. In general, the photocatalytic reactions by the vacuum ultraviolet light cannot be realized conventionally since the light is easily absorbed in air. Moreover the reactions are also different to the electrochemical reactions. The electrochemical reactions are governed by the regulated redox potential. Oppositely, SP catalytic reactions are governed by two potentials: reduction and oxidization potentials. SP can demonstrate vacuum ultraviolet light photocatalyst, which induces the novel reactions in atmosphere.

The SP catalyst can realize 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.

We have been already successful to synthesize the hetero-graphenes for conductive materials, semiconductor, quantum dots with CH activation reaction induced by SP catalyst. In this presentation, we demonstrate the reaction roles for solution plasma and the application of hetero graphene.

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