On self assembly of some functionalized [60]fullerenes in the Langmuir and Langmuir-Blodgett films

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A strategy of self assembly of selected C_{60} derivatives via complex formation in the Langmuir and Langmuir Blodgett films has been explored. This strategy consists in formation of the films of hydrophobic fullerene adducts in the interface of air and aqueous solutions of compounds capable of co-ordinating the adducts.

One example involved a C_{60}uracil adduct capable of recognizing, via the Watson-Crick pairing, complementary bases, such as adenine, adenosine, or adenosine 5'-triphosphate (ATP). In effect, stable "expanded liquid" Langmuir films of the C_{60}uracil-adenine, C_{60}uracil-adenosine and C_{60}uracil-ATP complexes were prepared on subphase solutions containing these bases. In a contrary case preliminary investigated, C_{60}adenine adduct was self assembled in Langmuir films, formed onto subphase of the uracil solution.

Another example included C_{60} adducts of imidazole, C_{60}im, and pyridine, C_{60}py, capable of axial co-ordination of zinc porphyrins. Therefore, water-soluble porphyrins, such as Zn tetrakis (N-methylpyridyl)porphyrin cation, Zn(TMPyP), or Zn tetrakis (4-sulfonato= phenyl)porphyrin anion, Zn(TPPS) were used for preparation of the subphase solutions. In effect, relatively stable complexes of C_{60}py-Zn(TMPyP) and C_{60}py-Zn(TPPS) as well as C_{60}im-Zn(TMPyP) and C_{60}im-Zn(TPPS) were formed in Langmuir films.

Simultaneously derived isotherms of surface pressure and surface potential vs. area per molecule as well as the in situ Brewster angle microscopy imaging revealed that all adducts are aggregated in the films. Therefore, limiting area per molecule at the infinite adduct dilution in films was determined by extrapolation of the actual area per molecule to the zero adduct content in the film. The resulting area was dependent on composition of the subphase solution. It increased in the order: water < adenine < adenosine < ATP solution for the C_{60}uracil films and water < Zn(TPPS) < Zn(TPMyP) solution for the C_{60}im and C_{60}py films. Comparison of the area per molecule, calculated and determined from the compression isotherms, as well as the dipole moment component vertical to the air-solution interface plane, calculated and determined from isotherms of surface potential vs. area per molecule, allowed one to postulate orientation of the adducts in films. Moreover, some evidences were acquired indicating two-dimensional phase transitions in films induced by extensive compression.

The Langmuir films were transferred, by using the Langmuir-Blodgett (LB) technique, onto quartz slides and characterized by the UV-vis spectroscopy as well as onto ITO electrode coated quartz slides and examined by cyclic voltammetry (CV) and quartz crystal vibrators and characterized by simultaneous CV and piezoelectric microgravimetry with the use of an electrochemical quartz crystal microbalance. It appeared that complexes formed in the Langmuir films were so stable that the co-ordinating agents initially dissolved in the subphase solutions were transferred together with the adducts. The adducts were electrochemically active in the LB films.