DIARYLETHENE DERIVATIVES FOR DESIGN OF DOWNSCALED CONTACT ELECTRODES MADE OF AU NANOPARTICLE ASSEMBLIES

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Design of nano-scaled devices based on gold nanoparticles (AuNP) cross-linked with functional molecules received considerable attention during recent years. 2D and 3D arrays of AuNP allowed the creation of downscaled contact electrodes, touch sensors as well as optically-, chemically- and mechanically-controlled resistors. Herein we present a stepwise approach towards nanoswitches with optically modulated electron conductance. Such switches are a combination of two gold nanoelectrodes (modeled with AuNPs) linked by photochromic diarylethene molecules (DAE). DAE can be switched reversibly between low- (open-ring form) and higher (closed-ring form) electron conductance states under visible and UV light irradiation, respectively. However, developing of nanoswitches requires: (i) optimization of molecular structure, (ii) stress testing of DAE in contact with gold nanoelectrodes under alternating UV-/visible light irradiation, i.e. variance of conductance, (iii) development of suitable verification of opto-electronical properties of designed nanodevice.

In contrast to widely used thiophene-based DAE, we use furan based DAE with oxygen instead of sulfur atoms in the photochromic core to suppress binding of molecules via the thiophene sulfur to the Au electrodes. A furan-based DAE with 4-mercaptophenyl-ethynyl linker-groups (Fig.1) showed sub-picosecond ring-closing kinetics under UV light irradiation, outperforming thiophene based switches in ethanol solution [1]. Moreover, in break-junction measurements reversible triggering of conductance was observed [2]. However, in a real circuit an assembly of DAE is expected to trigger conductance and to operate under ambient conditions. Experimental studies of an assembly of DAE sandwiched between a macroscopic, non-symmetric Au–reduced graphene-oxide electrode pair revealed excellent reversible conductance switching induced by UV-/visible light irradiation even under mechanical and thermal stress [3]. However, in electronic devices scaled to the nano size the occurrence of local plasmon resonance excitation (LSPR) in the Au-electrodes might interfere with the switching process since LSPR is stimulated at the wavelength of visible light which itself induces the formation of the low conductive open-state of DAE. Therefore, we study the effect of communication of AuNP (d ~18 nm) and furan-based DAE [4]. We found that reversible UV-\visible light irradiation led to reversible light absorbance triggering of AuNP decorated with DAE. Apparently, molecules are able to be switched in presence of LSPR, even though the mechanism of interaction of LSPR and DAE remains unclear

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