Dark states and Stark effects in multi-quantum-dot molecules

S. B. Tooski and B. R. Bułka
Institute of Molecular Physics, Polish Academy of Sciences,
ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

We consider the transport properties through a ring-shaped multi-quantum-dot molecules coupled to electrodes. The effects of an in-plane applied electric field and its rotation which breaks the symmetry of the system on wave functions, occupation probabilities of molecular states, an electronic polarization, current, as well as ground and excited states are analyzed. The Stark splitting is determined by the intensity of the applied electric field and its angle with respect to the axes of the molecule. For some interference conditions, the electric field can create a so-called dark state in which the probability to find the electron in one of the dots is zero and consequentely blocking the current in the dot can occur. The stationary current in the sequential regime using master equation approach is studied. It is shown that the electric field can induce a major changes in current. In particular, we analyze the conditions for the appearance of negative differential resistance due to dark states. The circumstances to create dark states and observe negative differential resistance in multi-quantum-dot molecules due to symmetry reasons are found. Transport through such a device is also discussed, where the molecule is attached to the leads in various configurations.

9.7 cm

13.4 cm

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Corresponding author :
S. B. Tooski

Address for correspondence :
Institute of Molecular Physics, Polish Academy of Sciences, ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

Email address :
tooski@ifmpan.poznan.pl