Questions and answers for Module 7

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1 Questions

1. What are the prerequisites for the nanophotonic device operations ?
2. Write the expression for the discrete energy levels for a CuCl semiconductor quantum dot.
3. Explain the principle of non adiabatic photo chemical vapour deposition.
4. How can one achieve hierarchical data retrieval in a nanophotonic device ?
5. Explain the dressed photon- coherent phonon model.

2 Answers

1.
   - Non-resonant exchange of dressed photons in the optical near field between nanometric particles should yield nutation.
   - Resonant exchange of free photons should be defected in the far field.
   - The resonant energy levles in the far field and the non-resonant energy levels in the near field should be discretized.
   - Coupling between two discrete energy levels should yield a symmetric state that is accessible in the far field.
   - In the optical near field, coupling between two discrete energy levels should also yield an anti-symmetric state along with the symmetric state.
   - When nanomaterial are excited by a far field, only allowed electric dipole energy levels are utilized.
   - When nanomaterials are excited by an optical near field, forbidden electric dipole energy levels and allowed electric dipole energy levels are utilized.
   - Spatial localization of each nanomaterial should be achieved. Global excitation of nanomaterials as a whole is not needed.
   - Spatial information and frequency information of nanomaterial systems should be made use off effectively.

2. $$E_{n_z,n_y,n_z} = E_b + \frac{(n_x^2 + n_y^2 + n_z^2)\pi^2\hbar^2}{2m(L-a_b)},$$

3. Non adiabatic photo chemical vapour deposition employs the principle of optical near field technology where the optical near field allows electric dipole forbidden energy transitions, thereby enhancing the spatial resolution capability of the optical near field.

4. In a nanometric subsystem consisting of N nanoparticles lying distributed in a region of sub wavelength scale, the size of the nanoparticles can be nicely resolved on employing a scanning near field microscope, when the size of its probe tip is comparable to the size of the individual nanoparticles. Thus, one can perceive a first layer information where one can retrieve information that is associated with each distribution of nanoparticles corresponding to 2^N different codes. One can further associate a second layer information corresponding to $(N+1)$ different codes when the size of the probe tip is much larger compared to the individual size of the nanoparticles. Thus, by manipulating the scale of observation, one can retrieve different sets of signals. Hence by devising an appropriate coding strategy, one can achieve hierarchical data retrieval by associating the information hierarchically with the distribution and the number of nanoparticles.

5. The Dressed photon-coherent phonon model is basically used for investigating the physical mechanism of photolithography. According to the model, the exciton-phonon

polaritons are generated at the apex of an optical near field probe. When gas and adsorbed molecules are placed very close to the optical near field probe tip, the exciton-phonon polaritons are transferred from the probe tip to the adsorbed gas molecules. The dressed photons incident into the probe-tip are responsible for the electronic excitations near the probe tip. These electronic excitations inturn result in the anharmonic coupling of the phonons, thereby forming a renormalized phonon. Hence multiple phonons can be thought of as coherent phonons in the original representation which can interact simultaneously with an exciton or an exciton polariton.