The Study of Cavitation Bubble- Surface Plasmon Resonance Interaction For LENR and Biochemical processes

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ABSTRACT
The cavitation bubble resonator (CBR) can be used as a new coupling technique. The purpose of this paper is to study coupled SPR-CBR, coupled CBR-Nickel and coupled CBR-Biochemical. It is expected the cavitation bubble resonator assists a pseudo coupling process. The design of nano CBR cell can play a significant role in the sciences of therapeutic drugs and power generation.

1. Coupled SPR –CBR

The evanescent field of a surface plasmon wave reaches its maximum strength directly at the metal-dielectric interface and decays exponentially into the electric medium at a distance of several hundreds of nanometers. Therefore the surface plasmon resonance(SPR) technique is extremely sensitive to changes of the optical properties of the adjacent dielectric medium.
Prism is used for enhancing the wave-vector of the incident light. Photons are not coupled directly to the metal/dielectric interface, but via the evanescent tail of the light which is totally internally reflected at the base of a high-index prism (with the dielectric constant $\varepsilon_p > \varepsilon_d$).
The modified propagation constant $k_{SPR,x}$ can written

$$k_{SPR,x} = k_x + \Delta k_x \qquad (1)$$

Where k_x is the propagation constant of the surface plasmon propagating along the metal-dielectric interface in the absence of the prism and Δk_x accounts for the finite thickness of the metal and the presence of the prism.
A resonator is a structure that can store energy such that is continuously converted with a specific rate between two kinds of energy. When the resonator oscillates, energy is converted from one kind to another and back. If more energy is fed to the resonator at the same frequency and in phase with the oscillations, energy will be absorbed and stored in the oscillator. If energy is continuously fed into a resonator, the amount of energy stored will grow until energy is dissipated with the same rate as new energy is stored[1],[2].

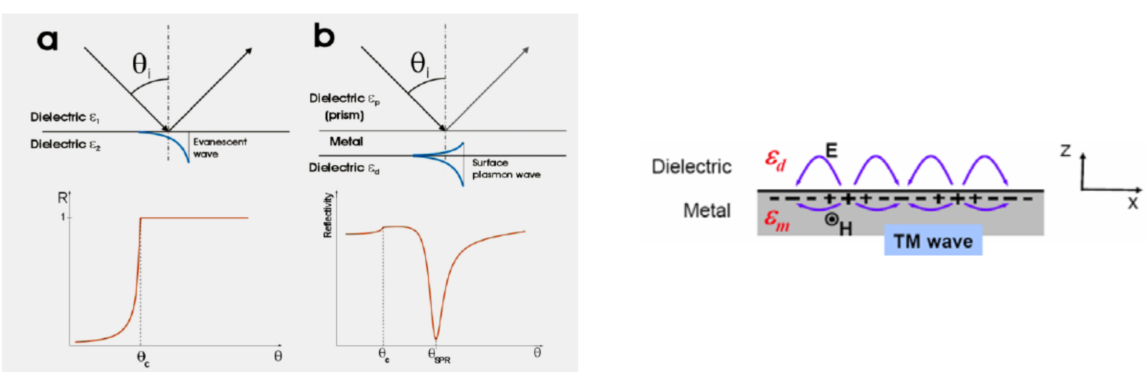

Fig.1 SPR propagate inside the dielectric (nano bubble)

Surface plasmon wave can be confined to a very small volume using nano-cavities or (nano)micro resonator with low dissipation inside a supercavity as a nano bubble. Moreover, wave inside the cavity can be controlled by dynamically changing the environment of the cavity. While surface plasmon wave propagate inside the nano bubble, nano bubble can play a significant role as a nano cavity.
The resonant frequency in a bubble cavity resonator along with reentrant jet caused by the collapsing bubble is assumed

$$f_0 = \frac{c}{2\pi}\frac{2.405}{R} \qquad (2)$$

In which c is the light speed and R the cavity radius.

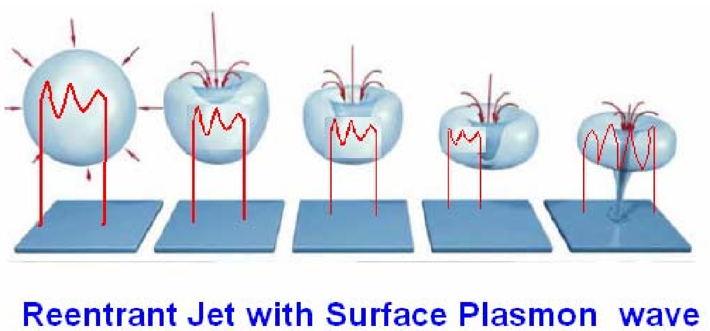

Fig.2 Reentrant jet formation with propagating surface plasmon wave

These two atoms such as hydrogen atoms can behave as two partly-reflecting mirrors, forming a cavity within-a-cavity or super-cavity like a bubble[3].

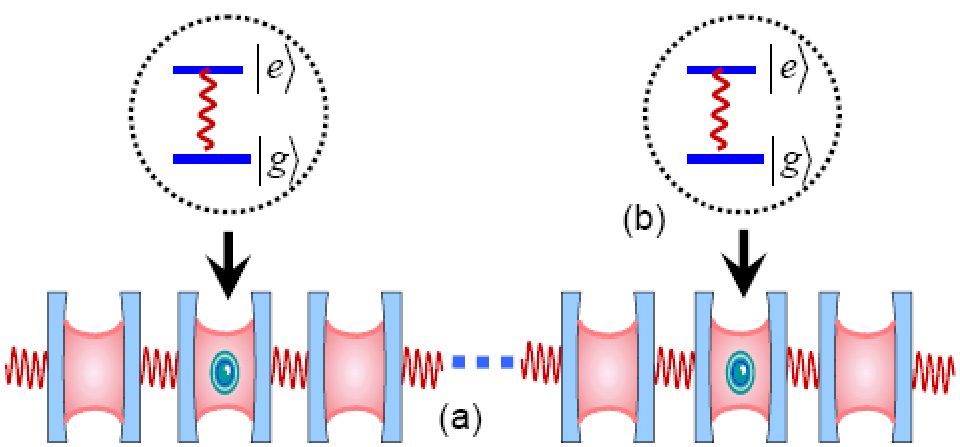

Fig.3 Schemtaic configuration for a quantum super-cavity realized
by two atoms embedded in two separated cavities of a coupled resonator waveguide.

A perfect quantum super-cavity, confining surface plasmon wave, can be formed when the transition energies of these two level systems are equal to the surface plasmon wave energy, with wave number $k=n\pi/(2d)$, where 2d is the distance between the two atomic scatters and n is an integer.
Wave-vector of N particles (including hydrogen atoms) inside the coupling bubble resonator(CBR) becomes:

$$k_{CBR}(\omega) = \sum_{i}^{N} k_{atom-atom}(\omega) \qquad (3)$$

$$k_{CBR}(\omega) = \beta \times k_{SPR}(\omega) \qquad (4)$$

β is reinforced factor of wave-vector (ω) in the coupling bubble resonator(CBR).

The momentum of the reinforced SPR wave propagating in the coupling resonator bubble transfer to the electron of hydrogen atom ($k_{electron,H}(\omega)$) in the coupling condition and is equal to

$$k_{electron,H}(\omega) = k_{CBR}(\omega) \qquad (5)$$

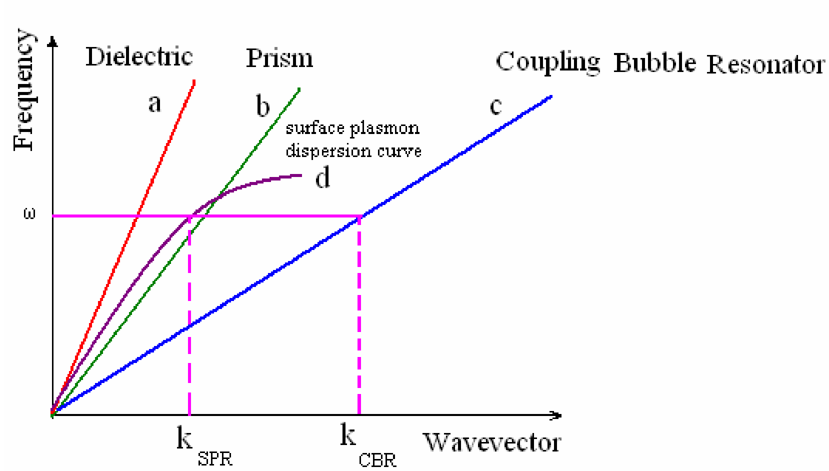

Fig.4 Dispersion relation of (a) free photons in a dielectric, b)free photons propagating in a coupling prism (c) free photons propagating in a coupling bubble resonator, and (d) the dispersion relation of surface plasmons at the interface between the metal and the dielectric in the three-phase prism-metal-dialectic system

2. Coupled CBR-Nickel

The wavevector of the photon and surface plasmon wave inside a resonator supercavity bubble will increase, subsequently the wavevector of the electron of hydrogen atom will increase. It means the atoms H will be excited to reach its Rydberge state. Its electron's trajectory becomes elliptic.

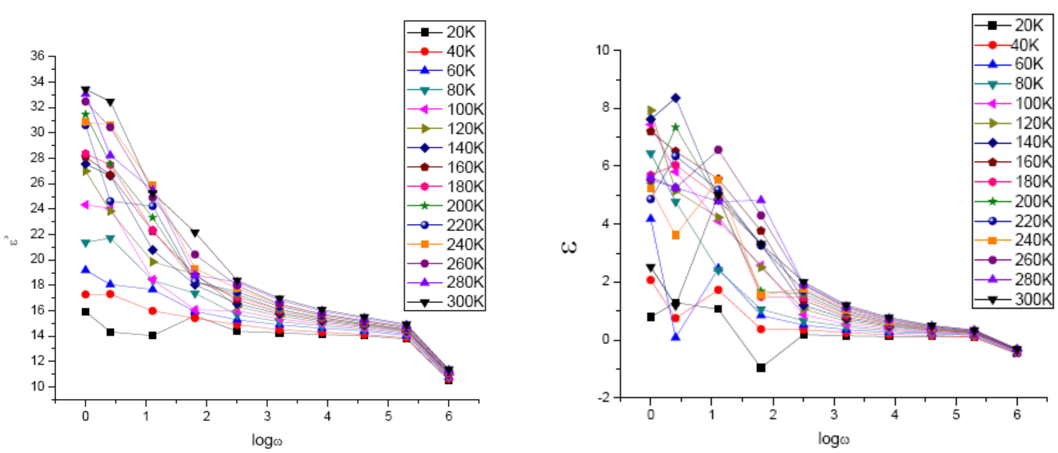

Fig. 5 Variations of dielectric constant and variation of imaginary part of dielectric constant with frequency(Hz) of nanocrystalline nickel

Thus, the atom act as a dipole. The generated dipoles can be polarized and guided to a target. For a brief period(of around 10^{-13} second), hydrogen proton is very close to its electron and can assume to reveal a pseudo hydrogen atom (Rydberge state).
Fig.5 shows the variation of dielectric constants with frequency at different temperatures for nanocrystalline nickel[4]. Table 1 shows some metals that will be used in these simulations and their respective plasma energies.

Metal	$\hbar\omega_p$(eV)
Ag	9.01
Au	9.03
Cu	10.83
Ni	15.92

Table 1: Metals and their plasma energy

Water is unique among molecules as it is full of hydrogen bonds. The hydrogen bonds in water make water more colorless than gas. The role of hydrogen bonding can be determined by comparing water in its gaseous and liquid phase. When comparing the vibrational transitions between gaseous and liquid water, there is a shift to lower energy induced by hydrogen bonding. The hydrogen bonding in water causes the stretching frequencies between water molecules to lower values, causing water to be clearer. If there were no hydrogen bonds, the blueness of the water would be more intense. There are three main factors that affect the color one sees in water. First, particles and solutes in the water can absorb light, altering its blueness.
Vibrational transitions are known to be the cause of the blueness of water because "heavy water" (D2O) has the same wavelength absorption curve as water but shifted to longer, slower frequencies as seen in Fig.6. The heavy water has no color as its vibrational transitions are slower than that of pure water. Ethylene glycol disrupts hydrogen bonding when dissolved in water. Due to its low freezing point ethylene glycol resists freezing.

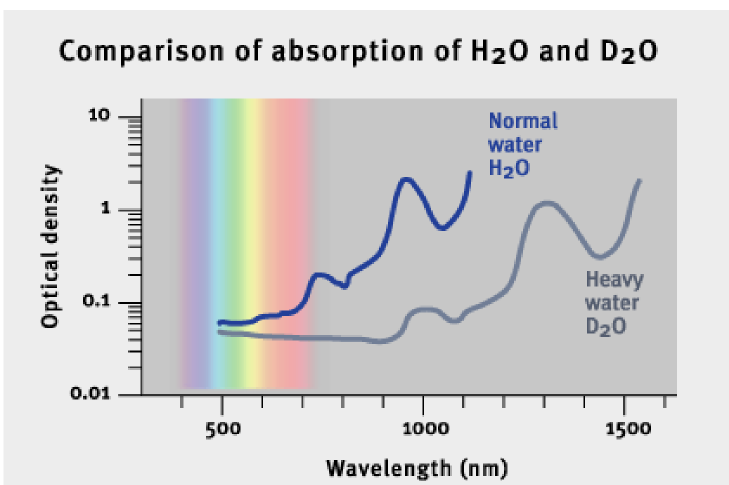

Fig.6 Optical density of water

The reentrant jet wave is reinforced by surface plasmon wave (caused by coupled resonator nano nickel rod-prism- bubble) in a resonator bubble cavity. The reentrant jet along with pseudo hydrogen atom (Rydberge state) collides with nano nickel rod and the major part of this reinforced reentrant jet wave will couple with nano nickel rod. The proton capture process performed by a Nickel nucleus produces a Copper nucleus according to the scheme

$$Ni^{X} + P^{1} \rightarrow Cu^{X+1} \qquad (6)$$

Copper nuclei, with the exception of the stable isotopes Cu63 and Cu65, decay with positron (e+) and neutrino (ν) emission in Ni nuclei .This is an exothermal process that releases LENR. Basis of SPR and nickel interaction, an initial design of nano CBR cell has been shown in Fig.6. The collision of the surface plasmon wave of reentrant jet would affect the reflecting signal from prism.

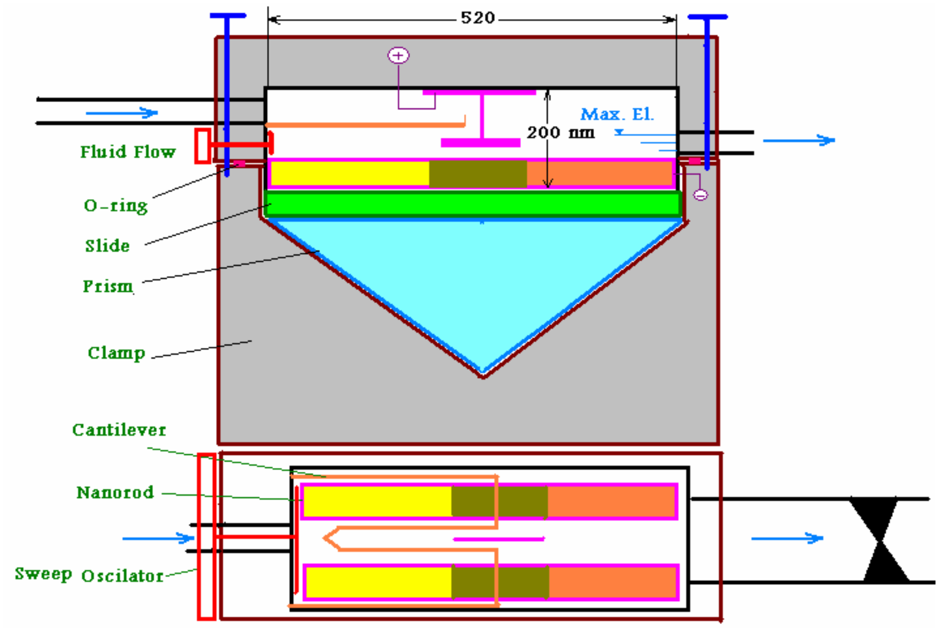

Fig.7 Nano CBR Cell.

The electric field and charge density of cavity resonator will be enhanced as surface plasmon is coupled with cavity resonator. Magnetic force is perpendicular to velocity and gives rise to circular motion (Gyromotion).The general motion of a particle in EM fields tends to be helical motion and as well particles tends to be tied to field lines. The external magnetic field made by Niobium (such as N51) can affect on the life time of the pseudo hydrogen atom (Rydberge state) and surface plasmon field.

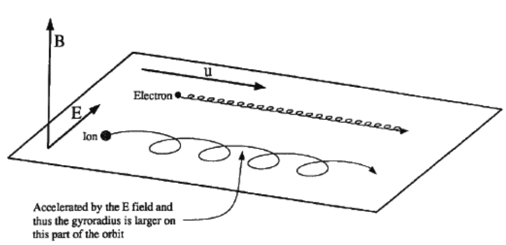

Fig.8 Gyromotion

3. <u>Coupled CBR-Biochemical</u>

Two following assumptions are employed to explain the pseudo binding reaction between antibody and antigen. Nano CBR cell can be applied in tests related to coupled CBR-Biochemical process.

- The pseudo hydrogen atom (Rydberge state) can be coupled and captured by antibody and antigen in the CBR, so new antibody and new antigen can be generated. The pseudo binding reaction probability will increase between generated new antibody and new antigen in the various combinations of antibody and antigen as follows:

$$\text{new-ab} + \text{ag} \leftrightarrow \text{new-ab:ag} \qquad (7)$$

- The high density of thermal energy in short time caused by LENR can be affected and assisted to the pseudo binding reaction in the CBR. The pseudo binding reaction probability will increase between generated new antibody and new antigen in the various combinations of antibody and antigen as follows:

$$\text{new-ab} + \text{ag} + \text{heat} \leftrightarrow \text{new-ab:ag} \qquad (8)$$

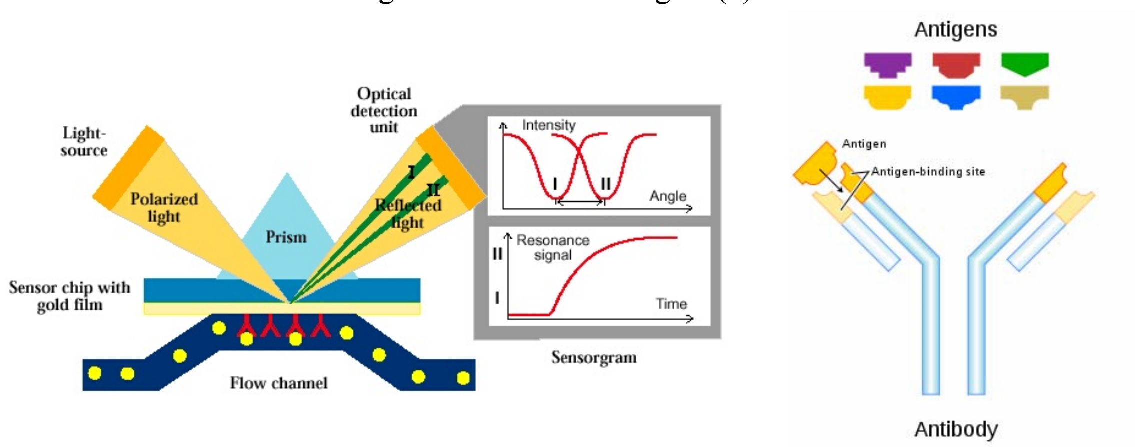

Fig.9 SPR-Biochemical process

As the antigen bind to the antibodies, the refractive index at the sensor surface will change and affect the SPR coupling conditions and reflected light.

Conclusion

The nano CBR cell help to investigate the coupling processes of pseudo hydrogen atom (Rydberge state) inside a supercavity. LENR process can be a kind of applications of coupled CBR-Nickel. Also, coupled CBR-Biochemical might considerably affect on the atomic coupling between antibodies and antigens in biochemical process and lead to improve antibodies and biosensors.

Reference

[1] M. Trnavsky, "Surface plasmon-coupled emission for applications in biomedical diagnostics", A thesis presented to Dublin City University, 2009.

[2]R. L. Earp Jr.," Multiwavelenght surface plasmon resonance sensor Designs for chemical and Biochemical Detection", A thesis presented to Virginia Polytechnic Institute and State University.

[3] L. Zhou, H. Dong, Y. X. Liu, C.P. Sun, F. Nori, "Quantum supercavity with atomic mirrors", Physical Review A., 2008.

[4] Satish, G.S. Okram, N. Gumpta, "Study of physical properties of nanocrystlline nickel" International Journal of engineering Research and development, vol. 3, pp.41-46, 2012.