行政院國家科學委員會專題研究計畫 成果報告

超導中渦漩運動和電磁超介質材料奇異特性的研究
研究成果報告(精簡版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 98-2112-M-216-001-
執 行 期 間 ：98 年 08 月 01 日至 99 年 08 月 31 日
執 行 單 位 ：中華大學電機工程學系

計 畫 主 持 人：楊宗哲

計畫參與人員：碩士班研究生-兼任助理人員：張育瑋
大專生-兼任助理人員：黃崇庭
大專生-兼任助理人員：葉正聰
大專生-兼任助理人員：謝毓鴻
博士班研究生-兼任助理人員：廖德超
博士班研究生-兼任助理人員：胡仲安
博士後研究：陳美頌

報 告 附 件 ：赴大陸地區研究心得報告
出席國際會議研究心得報告及發表論文

處 理 方 式 ：本計畫可公開查詢

中 華 民 國 100 年 01 月 05 日

NSC 98 Project Report

(I). Introduction

In this fiscal year, the outcome of this project is divided into two categories. One category is the property of vortex motion in superconducting Nb thin film with a spacing-graded array of holes. Second category is transmission properties of multilayer structure of photonic crystal and multilayer annular rings in cylinder, microwave propagation in corrugated structure on the edge of metallic film. Now let us summarize our results and brief introduction as following:

(2). Brief introduction and results

Vortex dynamics has been investigated in the mixed state of type II superconducting films with artificial regular arrays of pinning sites. Superconducting thin films with different shapes of pinning centers has been studied using experimental results as well as by numerical simulation. The pinning effect has been concentrated four- probe electric measurements and theoretical simulations. The commensurate effect is formed by a competition between the elastic energy of the vortices and the pinning energy at each pinning center.

To get insight of the physics of vortex dynamics in superconductors, the ratchet effect has been studied. The ratchet effect is studied for guiding the motion of the particles when the Brownian motion of particles is confined in asymmetric potentials. The influence of an asymmetric potential for vortex dynamics in superconductors has opened up a new field. The concept of the ratchet effect was explored by Villegas and Vicent(PRB 71, 24519(2005)). They reported on a reversible rectifier in an Nb thin film with a periodic array of triangular pinning sites. Later, the rectification effect in an Al film with a square array of asymmetric double-well pinning centers was done by Moshchalkov et al (PRL 94, 57003 (2005)).Reichhardt et al (PRB 75, 054502 (2007)) predicted that a vortex rachet system is created by an asymmetric periodic modulation. All these systems, the asymmetry is created by the asymmetry of the magnetic pinning centers.

A similar system has been done in Nb films with a semi-regular array of pinning centers by our group. A spacing-graded array of sub-micrometer-scaled holes was made on the Nb thin film, and some results were published in JAP 99, 08M515 (2006). In this work (SSC 150, 280-284 (2010)) the gradient of the hole array is increased. The

interesting results come out. The dc voltage as a function of ac current shows a well-defined nonzero sharp jump. The graded vortices cause a net vortex-vortex interaction force. The arrangement of the spacing-graded pinning arrays causes the rectification of the vortices. The rectified voltage has a drastic change for a large-gradient sample. It is suggested that a reversible vortex motion is induced by the interstitial vortices for a field above the first matching field. The ac-driven vortices exhibit a variety of dynamical responses and the rectified voltage is tunable with the applied magnetic field. Other work has been published in this project period, such as special pinning phenomena in superconductors with regular composite pinning arrays published in JAP 107, 09E129 (2010). A review article, I presented in the invited talk in NEWSC-7 Beijing last year, summarized all the recent work published in Journal of Superconductivity and Novel Magnetism 23, 1051-1054 (2010). The title of the paper is “Pinning effects in Nb thin films with artificial pinning arrays”.

The study of a Bragg reflector (BR) or one dimensional photonic crystal (1DPC) is interesting subject. The studies of the photonic band structures in a periodic multilayer structure consisting of superconducting and dielectric materials have been reported (Takeda et al, PRB 70, 085109(2004); C.J. Wu, M.S. Chen, T.J. Yang, Physica C 432, 133 (2005); Berman et al, PRB 74, 092505 (2006)). Such a superconducting planar Bragg reflector (SPBR) has some basic distinctions compared to an all-dielectric plane Bragg reflector. There exists a low frequency photonic band gap (PBG) due to the combined effects of periodicity and of incorporating superconducting materials. This low-frequency PBG is further tunable as a function of the temperature and the applied magnetic field as well. This tunable feature comes from the temperature- and field-dependent penetration length of a superconductor. Moreover, in the region near the threshold frequency of the bulk superconductor, which plays a similar role as the plasma frequency in metal, some extraordinary optical properties in an SPBR can be seen.(Arafa H. Aly, H.T. Hsu, T.J. Yang, C.J. Wu, C.K. Hwangbo, JAP 105, 083917 (2009)).

A Bragg reflector with an annular geometric structure has now been studied. By creating a ring defect into the annular periodic multilayer structure, an annular resonator or laser has been recently reported. In our work, the optical reflection properties of a superconducting annular Bragg reflector (SABR) are investigated. In our analysis we use the two-fluid model for the superconductor together with the transfer matrix method for the cylindrical waves developed by Kaliteevski et al. (J. Mod. Opt. 46, 875 (1999).). With the fact that the field solutions of the cylindrical waves are closely related to the azimuthal mode number, denoted by m, for both the

TE and TM waves, optical properties at different m-numbers are examined. It is found that an additional high-reflectance band or reflection dips near the threshold wavelength of a superconductor can be found for the TM wave at an azimuthal mode number m greater than or equal to one. These two distinct features behave like the localized pass-bands, which provide a feasible way of designing a narrowband transmission filter or an annular resonator without physically introducing any defect layer to break the periodicity of the structure. This work had been published in Solid State Communications 149, 1888-1893 (2009). A related work is also presented in ICPEPA-07 conference. The title is “Investigation of optical properties in near zer0-permittivity operation range for a superconductivity photonic crystal”.

Another annular structure is also studied. The optical reflection properties of an annular Bragg reflector (ABR) containing LiNbO3 are theoretically investigated. By changing the refractive index of LiNbO3 under the control of applied voltage, the locations of the band edges in the photonic band gaps can be tunable not only for planar Bragg reflectors but also for annular Bragg reflectors. Furthermore, the wavelength-dependent reflectance at mode number of m=0 is nearly identical to that of the planar one-dimensional Bragg reflector. The reflectance spectra for the TE wave at different values of m also given and compared. The PBG is narrowed down as m increases. Such filtering properties provide a feasible way of designing a refractometer optical sensing device.

For one-dimensional lossy DNG/DPS photonic crystal and superconducting photonic crystal, I cooperate with Prof. Chien-Jang Wu’s group to finish these subjects and published several journals. These papers are listed in my publication list. I do not want to introduce these subjects here. Next, I want to introduce another useful work.

Surface Plasmon (SPPs) are electromagnetic excitations that propagate in a wave-like fashion along the planar interface between a metal and a dielectric medium. SPPs provide the possibility of guiding electromagnetic waves beyond the diffraction limit. It would be greatly advantageous to take concept of highly localized SPPs to the microwave regime, which may open up a previously inaccessible length scale for microwave research, with promising applications in the miniaturization of microwave circuits, and microwave imaging and sensing. At microwave frequencies, however, metals resemble a perfect conductor as their plasma frequencies are often in the ultraviolet part of the spectrum, leading to SPPs highly delocalized on both flat and cylindrical surfaces. As a consequence, SPPs suffer serious radiation loss (due to bends or nearby objects) and undesired coupling between adjacent waveguides. To enable confinement of electromagnetic fields at lower frequencies, an idea of engineering surface Plasmon at any frequency was proposed (Pendry et al, Science,

vol. 305, 847-848, 2004.). That is, by cutting holes or grooves in flat metal surfaces to increase the penetration of electromagnetic fields into the metal, the frequency of exisiting surface plasmons can be tailed at will. The existence of such geometry-controlled SPPs, namely spoof SPPs, has been verified experimentally in the microwave regime. It also had been reported that spoof SPPs at terahertz (THz) frequencies can be sustained on periodically corrugated metal wires (MIER et al, PRL 97, 176805-1-4 (2006); Chen et al, Optics Express, Vol. 14, 13021-13029 (2006)). The absorption loss of spoof SPPs in corrugated wires has also been studied at THz frequencies. A periodically corrugated wire, whose outer radius is of sub-wavelength size, can be properly designed to achieve both sub-wavelength guiding and low loss at microwave frequencies. (J.J. Wu, T.J. Yang, L.F. Shen, J. Electromagnetic Waves and Appl., Vol. 23, 11-19 (2009)). The outer radius of the corrugated wire is of sub-wavelength size, and it seems difficult for spoof surface plasmon polaritons in the wire to be confined highly, even if the set of the geometric parameters of the wire structure is optimized. However, if the grooves of the corrugated wire are filled with a dielectric with high permittivity, the strong field confinement of spoof SPPs can be achieved even at frequencies smaller than the asymptotic frequency, for which the SPPs losses are quite low. For this type of wire structure, the sub-wavelength microwave guiding is available for a certain frequency range. From this work, we (J.J. Wu and I apply the patent for Reduction talk between a conventional structure and corrugated structure of transmission line in microwave transmission) later proposed a new structure of transmission lines for microwave propagation and finally do experimental verification by our group. We published a series papers such as Electronics Letters, 46, 1273-1274 (2010); Plasmonics, to be published in 2011, January. For terahertz surface plasmon polaritons on a periodically structured metal film with high confinement and low loss , this work is published in J. Electromagnetic Waves and Applications, Vol. 23, 2451-2460 (2009). Another different structure, the backward guiding of terahertz radiation in periodic dielectric waveguides is studied and published in J. Electromagnetic Waves and Applications, Vol. 24, 557-564(2010).

(3). Future work

In June 2010, Prof. S.Q. Shen was invited to visit us for five months to open up a new field for us to do electromagnetic induced transparency medium in multilayer periodic system to study a frequency sensitive tunable band structure and propose new applications. This comes out a series of papers was and will be published in international journals and conferences. In the coming project, we will

direct along this subject to dig out new physics and applications.

(4). Acknowledgement

I would say in this project we had done very rich results and applications. More than 15 papers and several conference papers are published. Many papers are presented in the international conferences and inside country conferences. You may see my publication list. Hence I would sincerely like to thank National Science Council to support my trip to attend international conferences and my Ph.D. student's salary to do research peacefully, project funding to let me do a small experimental test our idea and simulation.

(5). Publication list in 2009 and 2010 :

2009-2010,11,20 Research Achievement

TZONG-JER YANG
Professor; Department of Electrical Engineering, Chung Hua University, Hsinchu, Taiwan, Rep. of China. (2007 - Present)

(I). **International conference and Symposium: Session Organizer, Session Chair,** Invited Speaker.

1. **Session Organizer** in PIERS International conference 2009 in Beijing, China. (March 23-28).
2. **Invited Speaker** in The Seventh International Conference on New Theories, Discoveries, and Applications of Superconductors and Related Materials, May 13-16, 2009, Beijing, China.
3. **Session organizer** and **Session Chair** in PIERS International conference in . Moscow, Russia. (Aug. 18-21, 2009)
4. **Session organizer** in PIERS International conference in Xian, China. (March 22-26, 2010).

(II). Publication List: 2009 - 2010, 11, 20
Star " * " is paper published in NCTU.

2009 Papers:

1. J.M. Chen, J.M. Lee, T.L Chou, K.T. Lu, K.S. Liang , Chien-Te Chen, H.T. Jeng, S.W. Hwang ,**Tzong-Jer Yang,** C.C. Shen, Ru-Shi Liu, Jiunn-Yuan Lin, Z. Hu, "Bonding anisotropy in multiferroic TbMnO3 probed by polarization dependent X-ray

absorption spectroscopy", **Applied Physics Letters** 94, 041105 (2009, 27 Jan.). (IF=3.554) *

2. R. Cao, Lance Horng, T. C. Wu, J.C. Wu, and **T.J. Yang, "**Temperature dependent pining phenomenon in superconducting Nb films with triangular and honeycomb pining arrays" , **J. Phys.: Condensed Matter** 21, 075705 (2009, Jan. 23). (IF=1.964)
3. J. M. Chen, T. L. Chou, **J. M. Lee**, S. A. Chen, T. S. Chan, C. K. Chen, K. T. Lu, H.-S. Sheu, C. M. Lin, N. Hiraoka, H. Ishii, **T. J. Yang**" Pressure-induced structural distortion of $TbMnO_3$: A combined XAS and XRD study", **Phys. Rev. B**79, 165110 (2009).(IF=3.475) *
4. M.N. Ou, **T.J. Yang,** and Y.Y. Chen, "Anisotropic magnetism and magneto-resistance in iron nanowire arrays", **Chinese J. of Physics** 47, 847-852 (2009, 12). (IF=0.515)
5. Szu-Cheng Cheng , Jing-Nuo Wu, **Tzong-Jer Yang**, and Wen-Feng Hsieh , "Effect of atomic position on the spontaneous emission of a three-level atoms in a coherent photonic band gap reservoir", **Physical Review A**79, 013801 (2009, 01). (IF=2.866)
6. Jin-Jei Wu, **Tzong-Jer Yang,** and Linfang Shen, "Sub-wavelength microwave guiding based on surface plasmon polaritons", **J. of Electromagnetic Waves and Application,** vol.23, 11-19, (2009, 01). (IF=1.551)
7. Chien-Jang Wu, Heng-Tung Hsu, and **Tzong-Jer Yang,** "Microwave resonant transmittance in a super-conducting Fabry-Perot two-layer coating", **J. of Superconductivity and Novel Magnetism**, 22, 487-493 (2009, July; Feb. online published) .(IF=0.831)
8. Yang-Hua Chang, Chi-Chung Lin, **Tzong-Jer Yang**, and Chien-Jang Wu, "Angular dependence of a narrow band reflection-and –transmission filter containing an ultrathin metallic film", **J. Optical Society of American B**26, 1141-1145 (2009,05,01). (IF=2.087)
9. Arafa H. Aly, Heng-Tung Hsu, **Tzong-Jer Yang**, Chien-Jang Wu, and Chang Kwong Hwangbo, "Extraordinary optical properties of a superconducting periodic multilayer structure in near zero permittivity operation range", **J. of Applied Physics** 105, 083917 (2009,04,24). (IF=2.072). This paper is selected by Virtual Journal of Superconductivity.
10. Mei-Soong Chen, Chien-Jang Wu, **Tzong-Jer Yang,** "Optical properties of a superconducting annular periodic multilayer", **Solid State Communication,** 149, 1888-1893, (Nov., 2009; online published in Aug. 6, 2009.). (IF=1.837)
11. Mei-Soong Chen, Chien-Jang Wu, **Tzong-Jer Yang**, "Wave properties of an

annular periodic multilayer structure containing the single-negative materials", **Physics Letters A** 373, issue 39, 3594-3600(21 Sept. 2009; online published on 8 Aug.,2009). (IF=2.009)

12. Wen-Long Liu, Yeuh-Yeong Liou, Jung-Chun Wei, and **Tzong-Jer Yang**, "Band gap studies of 2D photonic crystals with hybrid scatterers", **Physica B** 404, issue 21, 4237-4242, Nov. 15, 2009. (IF=1.056)
13. J.J. Wu, D. Chen, K. L. Liao, **T. J. Yang**, and W. L. Ouyang, "The optical properties of Bragg fiber with a fiber core of 2-dimension elliptical-hole photonic crystal structure", **Progress in Electromagnetic Research Letters**, Vol. 10, 87-95, 2009.(EI, no impact factor, no SCI)
14. Chien-Jang Wu, Cheng-Li Liu, and **Tzong-Jer Yang,** "Investigation of photonic band structure in a one-dimensional superconducting photonic crystal", J**ournal of Optical Society of America B**26, No.11, 2089-2094 (Nov., 2009). (IF=2.087)(selected for December 1, 2009 issue of Virtual Journal of Applications of Superconductivity.)
15. Chi-Chung Liu, Yang-Hua Chang, **Tzong-Jer Yang,** Chien-Jang Wu, "Narrowband filter in a heterostructured multilayer containing ultrathin metallic films", **Progress in Electromagnetic Research** 96, 329-346 (2009,09, 25). (IF=3.763)
16. X.F. Zhang, L. F. Shen, J. J. Wu, and **T.J. Yang,** "Terahertz surface plasmon polaritons on a periodically structured metal film with high confinement and low loss", **J. of Electromagnetic. Waves and Applications**, Vol. 23, 2451-2460, 2009. (IF=1.551)

2010 Papers:

17. T.C. Wu, R. Cao, **T.J. Yang**, Lance Horng, J.C. Wu, Jan Kolacek, "Rectified vortex motion in an Nb film with a spacing-graded array of holes", **Solid State Communications** 150, 280-284 (2010,02). (IF=1.837)
18. R. Cao, Lance Horng, **T. J. Yang**, T. C. Wu, J. C. Wang, and J. C. Wu, "Special pinning phenomena in superconductors with regular composite pinning arrays", **J. Appl. Phys**. 107, 09E129 (2010). (IF=2.072)
19. R. Cao, Lance Horng, J.C. Wu, **T.J. Yang**, T.C. Wu, "Pinning effects in Nb thin films with artificial pinning arrays", **Journal of Superconductivity and Novel Magnetism** 23, 1051-1054, (2010). (IF=0.831)
20. Heng-Tung Hsu, Kuan-Chung Ting, **Tzong-Jer Yang,** Chien-Jang Wu, "Investigation of photonic band gap in a one-dimensional lossy DNG/DPS photonic crystal", **Solid State Communications** 150, 644-647 (2010),(online published on 24 Dec., 2009). (IF=1.837)

21. J. M. Chen, **J. M. Lee**, S. W. Huang, K. T. Lu, H. T. Jeng, C. K. Chen, S. C. Haw, T. L. Chou, S. A. Chen, N. Hiraoka, H. Ishii, K. D. Tsuei, and **T. J. Yang**, "intra-site and inter-site electronic excitations in multiferroic $TbMnO_3$ probed by resonant inelastic X-ray scattering", **Phys. Rev. B 82**, 094442 (2010).(IF=3.475) *
22. Xufeng Zhang, Linfang Shen, Jin-Jei Wu, and **Tzong-Jer Yang,** "Backward guiding of terahertz radiation in periodic dielectric waveguides", **Journal of Electromagnetic Waves and Application** 24, 557-564,2010. (IF=1.551)
23. Chien-Jang Wu, Yao-Li Chen, **Tzong-Jer Yang**, "Effective surface impedance of a high-temperature superconductor film in semiconductor plasma substrate at mid-infrared frequency", **Journal of Superconductivity and Novel Magnetism**, 23,545-550(2010).(online 25 February, 2010). (IF=0.831)
24. C. J. Wu, Y. H. Chung, B. J. Syu, and **T. J. Yang**, "Band gap extension in a one-dimensional ternary metal-dielectric photonic crystal", **Progress in Electromagnetic Research** 102, 81-93 (2010). (IF=3.763)
25. Chien-Jang Wu, Zheng-Hui Wang, **Tzong-Jer Yang**, "Angle- and Thickness-Dependent photonic band structure in a superconducting photonic crystal", **Journal of Superconductivity and Novel Magnetism**, 23, 1395- 1399, 2010. online publication, 26 May, 2010. (IF=0.831)
26. J.J. Wu, Y.H. Kao, H.F. Lin, **T.J. Yang,** D.C. Tsai, H.J. Chang, C.C. Li, I.J. Hsieh, L.F. Shen, and X.F. Zhang, "Crosstalk reduction between metal-strips with subwavelength periodically corrugated structure", **Electronics Letters**, 46, No. 18,1273-1274, 2nd September 2010. (IF=0.971)
27. Jin Jei Wu, Hung Erh Lin, Tzong-Jer Yang, Hung Jung Chang, Ing-Jar Hsieh, "Low-Frequency surface plasmon polaritons guided on a corrugated metal striplines with subwavelength periodical inward slits", **Plasmonics**, online publication: 12 October, 2010. (IF=3.723)
28. J. M. Chen, **J. M. Lee**, T. L. Chou, S. A. Chen, S. W. Huang, H. T. Jeng, K. T. Lu, T. H. Chen, Y. C. Liang, S. W. Chen, W. T. Chuang, H.-S. Sheu, N. Hiraoka, H. Ishii, K. D. Tsuei, Eugene Huang, C. M. Lin, **T. J. Yang**, "Pressure-dependent electronic structures in multiferroic $DyMnO_3$: a combined lifetime-broadening-suppressed x-ray absorption spectroscopy and *ab* initio electronic structure study", **J. Chem. Phys.** 133, 154510(2010),7 pages. (online publication 19 Oct., 2010) (IF=3.093)
29. Heng-Tung Hsu, Tsung-Wen Chang, **Tzong-Jer Yang**, Bo-Han

Chu, Chien-Jang Wu, "Analysis of wave properties in photonic crystal narrowband filters with left - handed defect", **J. of Electromagnetic Waves and Application**, 24, 2285-2298, 26 Oct., 2010.(1.551)

30. T.C. Liao, J.J. Wu, J.Q. Sheng, **T.J. Yang,** " "The Sensitive Band Structure of an EIT Photonic Crystal and Its Application to Photonic Logic Gate Design" , to be published in **International Review of Physics, Oct. 2010. (no IF, no SCI)**
31. W.-H. Lin, C.-J. Wu**, T.-J. Yang,** S.-J. Chang**, "**Terahertz intrinsic and effective surface impedances of high-temperature superconducting thin films**", *J. of Electromagnetic Waves and Application*, *Vol. 24, 2589–2603, 2010.* *(published on Nov. 15) (1.551)***

(III). Conference Papers:

1. R. Cao, **T.J. Yang**, T.C. Wu, Lance Horng, "Novel pinning phenomena in Nb thin films with the hetero-structure pinning arrays", **J. of Physics: Conf. Ser.** 150, 052030 (2009, 31 March, online published). (1.9)
2. Kun-Lin Liao, Jin-Jei Wu, **Tzong-Jer Yang**, Daru Chen, and Linfang Shen, "A novel fiber sensor based on a Bragg fiber with a defect layer", **PIERS** 2009 Beijing, 2009, 03, 23-27; page 193.
3. Jin-Jei Wu, **Tzong-Jer Yang**, Kun-Lin Liao, Daru Chen, and Linfang Shen, "Highly birefringent Bragg fiber with a fiber core of 2-dimension elliptical-hole photonic crystal structure", **PIERS**, Beijing, China, March 23-27, 2009. Page 185.
4. Jing-Nuo Wu, **Tzong-Jer Yang**, Szu-Cheng Cheng, Wen-Feng Hsieh, "Spontaneous emission of a three-level atom in a coherent photonic band gap reservoir", presented in **CLEO /Pacific Rim 2009 conference**(Aug. 31-Sept. 4, 2009, Shanghai, Chna) and published in IEEE Conference-2009 (IEEE Xplore).
5. Teh-Chau Liau, Jin-Jei Wu, Jian Qi Shen, **Tzong-Jer Yang**, "Frequency-Sensitive Optical Response via Tunable Band Structure in an EIT-Based Layered Medium**",** *Advanced Materials Research Vols. 160-162 (2011) pp 1432-1439. Online available since 2010/Nov/11.*

(IV). Papers Presented in Conferences:

2009

1. T.C. Wu, R. Cao, Lance Horng, and **T.J. Yang**, "Superconducting vortex pinning with artificial magnetic nanostructures", Presented in **2009 Annular Meeting of Physical Society of Republic of China**, National Chang Hua university of

Education, Changhua, 2009, 01, 19-21.

2. R. Cao, Lance Horng, T.C. Wu, J.C. Lin, J.C. Wu, **T.J Yang**, "Missing Matching Peaks in Nb Thin with Square Pinning Arrays", Presented in **2009 Annular Meeting of Physical Society of Republic of China**, National Chang Hua University of Education, Changhua, 2009,0 1,19-21
3. J.C. Wang, T.C. Wu, R. Cao, J.C. Wu, **T.J. Yang**, and Lance Horng, "Mechanism of vortex pinning by honeycomb arrays of submicrometric defects in a superconducting Nb film", Presented in **2009 Annular Meeting of Physical Society of Republic of China**, National Chang Hua University of Education, Changhua, 2009, 01, 19-21.
4. Kun-Lin Liao, Jin-Jei Wu, **Tzong-Jer Yang**, Daru Chen, and Linfang Shen, "Highly birefringent Bragg fiber with a fiber core of 2-dimension elliptical-hole photonic crystal structure", Presented in **2009 Annular Meeting of Physical Society of Republic of China**, National Chang Hua University of Education, Changhua, 2009,01,19-21.
5. Jin-Jei Wu, Daru Chen, Kun-Lin Liao, **Tzong-Jer Yang**, and Linfang Shen, "A novel fiber sensor based on a Bragg fiber with a defect layer", Presented in **2009 Annular Meeting of Physical Society of Republic of China**, National Chang Hua University of Education, Changhua, 2009,01,19-21.
6. Daru Chen, **Tzong-Jer Yang**, Jin-Jei Wu, Linfang Shen, "A novel band-rejection filter based on a Bragg structure", **PIERS** 2009 Beijing, 2009,03, 23-27.
7. Jin-Jei Wu, **Tzong-Jer Yang,** Kun-Lin Liao, Daru Chen, and Linfang Shen, "Highly birefringent Bragg fiber with a fiber core of 2-dimension elliptical-hole photonic crystal structure", **PIERS** 2009 Beijing, 2009, 03, 23-27.
8. Kun-Lin Liao, Jin-Jei Wu, **Tzong-Jer Yang**, Daru Chen, and Linfang Shen, "A novel fiber sensor based on a Bragg fiber with a defect layer", **PIERS** 2009 Beijing, 2009, 03, 23-27.
9. **T.J. Yang**, T.C. Wu, Lance Horng, R. Cao, and J.C. Wu, "Pinning effects in Nb thin films with artificial pinning arrays", **New3SC-7**, Beijing, 2009, 05, 13-15.
10. C.J. Wu and **T.J. Yang**, "Analysis of optical properties in a superconducting photonic crystal", **New3SC-7**, Beijing, 2009, 05, 13-15.
11. Jin-Jei Wu, **Tzong-Jer Yang**, and Linfang Shen, "Sub-wavelength microwave guiding on a periodically corrugated metal wire", **PIERS** 2009 Moscow, 2009, 08, 18-21.
12. Yuan-Fong Chau and **Tzong-Jer Yang**, "Scattering field interactions and surface Plasmon resonance in a coupled silver nano-capsule", **PIERS** 2009 Moscow, 2009, 08, 18-21.
13. Yuan-Fong Chau, Din Ping Tsai, and **Tzong-Jer Yang**, "Enhanced surface Plasmon

effects excitation from several pair arrays of nano-shell structures", **PIERS** 2009 Moscow , 2009,08,18-21.

14. Heng-Tung Hsu, **Tzong-Jer Yang**, Chien-Jang Wu, "Design rules for a multilayer Fabry-Perot narrow band transmission filter containing a metamaterial negative-index defect", **PIERS** 2009 Moscow, 2009, 08, 18-21.
15. Mei-Soong Chen, Chien-Jang Wu, **Tzong-Jer Yang**, "Optical properties of an annular periodic multilayer structure containing superconductors", **Optics and Photonics, Taiwan** 2009, Dec. 11- 12, 2009.

2010

16. Y.H. Chen, M.W. Yang, T.C. Wu, R. Cao, **T.J. Yang**, J.C. Wu, Lance Horng, "Hall effect in Nb thin films with channeled pinning potential landscapes", **Annual Meeting of Chinese Physical Society**, Feb.2 to Feb. 4, 2010, at National Cheng Kung University, Tainan, Taiwan.
17. M.W. Yang, Y.H. Chen, T.C. Wu, R. Cao, **T.J. Yang**, J.C. Wu, Lance Horng, "Coupled motion of vortices between two superconducting films", **Annual Meeting of Chinese Physical Society**, Feb. 2 to Feb. 4, 2010, at National Cheng Kung University, Tainan, Taiwan.
18. R. Cao, Lance Horng, T.C. Wu, J.C. Wu, **T.J. Yang**, "Study of pinning phenomena in superconducting films with composite pinning arrays", **Annual Meeting of Chinese Physical Society**, Feb. 2 to Feb. 4, 2010, at National Cheng Kung University, Tainan, Taiwan.
19. Mei-Soong Chen, Chien-Jang Wu, **Tzong-Jer Yang**, "The optical properties of an annular periodic multilayer structure with two different single-negative materials", **PIERS** 2010 Xian, March 22-26, 2010, China.
20. Chien- Jang Wu, **Tzong-Jer Yang**, "Angle- and Thickness- dependent photonic band structure for a one-dimensional superconducting photonic crystal", **PIERS** 2010 Xian, March 22-26, 2010, China
21. Mei-Soong Mei, Chien-Jang Wu, **Tzong-Jer Yang**, "Investigation of optical properties in near-zero-permittivity operation range for a superconducting photonic crystal", **ICPEPA-7**, 15-20 August 2010, Copenhagen and Sonderborg, Denmark.
22. Chien-Jang Wu, Tsung-Wen Chang, Zheng-hui Wang, **Tzong-Jer Yang**, "Investigation of resonant peaks in the symmetric and asymmetric multilayer narrowband transmission filters", **ICPEPA-7** ,15-20 August 2010, Copenhagen and Sonderborg, Denmark.
23. **Tzong-Jer Yang**, Yuan-Fong Chau, Han-Hsuan Yeh, "Analysis of dispersion properties of rotational elliptic air hole photonic crystal fiber", **ICPEPA-7** ,15-20

August 2010, Copenhagen and Sonderborg, Denmark.

24. Mei-Soong Chen, Chien-Jang Wu, **Tzong-Jer Yang**, "Tunable filtering properties of an annular periodic multilayer structure containing lithium niobate", **16th Microoptics Conference(MOC'10)**, Hsinchu, Taiwan, Oct 31-Nov 3, 2010.

25. Jin Jei Wu, Yao Huang Kao, Hung Erh Lin, **Tzong-Jer Yang**, Di Chi Tsai, Hung Jung Chang, Chun Cheng Li, Ing-Jar Hsieh, Linfang Shen, and Xufeng Zhang, **16th Microoptics Conference(MOC'10)**, Hsinchu, Taiwan, Oct 31-Nov 3, 2010.

26. The-Chau Liau, Jin-Jei Wu, Jian-Qi Shen, **Tzong-Jer Yang,** "Extraordinary ray response on LHM and EIT Bi-layered medium", **The 15 th National Conference on Vehicle Engineering,** Nov. 26, 2010, Southern Taiwan University, Tainan, Taiwan, R.O.C.

27. Teh-Chau Liau, Jin-Jei Wu, Jian Qi Shen**, Tzong-Jer Yang,"**Band structure of 1 D infinite periodic dielectric and EIT Bi-layered medium", Optics and Photonics 2010 Taiwan, Dec. 3-4, 2010, Nan-Taiwan University, Tainan, Taiwan, Rep. of China.

(V). Affiliation and **honors:**

1. **Investigator** of The physical society of Republic of China.(two year terms)
2. **Member** of AAPT(American Association of Physical Teachers).
3. **Member** of The Physical Society of Republic of China.
4. **Member of Sigma Xi.**
5. **Life member** of Material Science Society of Republic of China.
6. **Fellow of Electromagnetics Academy.**

中 國 科 學 院 物 理 研 究 所

INSTITUTE OF PHYSICS, CHINESE ACADEMY OF SCIENCES

P. O. Box 603, Beijing, 100080, China

Tel: +86-10-82649080

Fax: +86-10-82649531

E-mail:guby@aphy.iphy.ac.cn

楊宗哲教授
國立交通大學電子物理系所
新竹市,大學路 1001 號
臺灣

楊宗哲教授道鑒:

1998 年我曾经赴臺灣到貴系進行四個月的短期訪問，與你有過愉快的合作研究經歷，並取得一些結果。在 2000 年末至 2001 年 6 月底，我受到你的邀請，再次赴臺灣，到你的研究組進行學術交流和合作研究，取得很有意義的結果。今特別希望我們已經開始的在光子晶體和表面等离子体元件設計方面的研究合作能繼續下去，特誠懇的邀請你於 2010 年 7 月底，8 月初，到中國科學院物理研究所，进行爲期十天的訪問。期盼著你早日來訪。

順祝

研安！

(顧本源教授)
中國科學院物理研究所
2010 年 6 月 28 日

參加第七屆光激發過程與應用國際會議

(ICPEPA—7)

16-19 August 2010 , Copenhagen , Denmark

報告撰寫人：楊宗哲
中華大學電機工程系

一、會議經過

8 月 14 日晚上乘泰國航空的飛機，先到曼谷，再直飛哥本哈根。8 月 15 日清晨到達哥本哈根，就直接到住宿旅館，下午就去會場註冊及領取會議議程，明白隔天的議程及演講主題、壁報場所。

此次大會係由哥本哈根區四個主要大學合辦會議地點在接近 Orsted Institute 之 Lundbeck Auditoret 演講廳，可說花了一段時間才找到，參與人數一百多人，算是小型會議，但相互交談和彼此認識時間長，大會主席 Jorgen schou 易與人們相處，講話幽默，所以在會議期間相處得很愉快，我們的宴會是 Neel Bohr 曾活動的建築物內舉行，Schou 就介紹 Bohr 的趣事。可說有意義的會議，這個會議第一次在日本仙台舉行，難怪會議中參與的日本人較多。

第一天會議較精彩的是飛秒電子繞射現象，由 Dwaine Miller 主講 及 Peter Varga 主講的脈波雷射鍍膜，在原子尺寸上成核與成長。Harold Haugen 主講快速雷射與 IV 族材料的相互作用。

第二天由 Leonid Zhigile 主講 Atomistic Simulations of laser interactions with metals：Melting of nanocrystalline films and generation of crystal defects. Motoichi ohtsu 主講 precipitation of ferromagnetic nanoparticles inside transparent glass by femtosecond laser 。 及 Paolo M Ossi 主講 Nanoparticles produced by laser ablation 。 第三天(8 月 18 日)由 Salvatore Amoruso 主講 Double pulse ultrafast laser ablation of metals 及 Candice Mezel 主講 Surface and bulk structuration of solid and liquid dielectrics.

第四天(8 月 19 日)由 Chunlei Guo 主講 Black and Colored metals. 底下將就個人所聽的演講做一簡略的心得報告，當中會附上一些投影片 。

二、與會心得

在本次會議中，我有三篇論文發表，一為 Investigation of optical properties in near zero permittivity operation range for a superconducting photonic crystal,二為 Analysis of dispersion properties of rotational elliptic air hole photonic crystal fiber . 三為 Investigation of resonant peaks in the symmetric and asymmetric multilayer narrowband transmission filters.

(a) Simon Mariager 主講 Direct observation of acoustic oscillation in InAs nanowires. 利用 time-resolved X-ray 繞射與光反射率，直接量測 InAs 奈米線的三個不同聲音的振動，這些震盪藉由飛秒雷射脈波激發，他以三個不同時間尺度演進.量測基本的 breathing eigenmode 的起始徑向膨脹的絕對尺寸，而以 transient optical reflectivity 決定其頻率，對於 extensional eigenmode , 量測平均徑向及軸向晶格常數的震盪及決定震盪的振幅和平均延伸量。最後觀測奈米線的彎曲運動, eigenmodes 的頻率與連續彈性理論的預測一致，且發現 Wurtzite 奈米線和立方晶體的聲速相同，但應變會受到不同 modes 間相互作用所影響。

(b) Thomas Lippert 主講 oxyen diffusion in SrTiO3 and LaAlO3 thin films pulsed laser deposition。 氧化物薄膜與基底中氧缺陷對它們的傳輸性質有急速變化效應 。就以介電材料 SrTiO3 來說,小量的缺陷就足以產生電的傳導。要了解以脈衝雷射蒸渡氧化物薄膜成長過程中氧的演變,就需觀察氧的擴散和薄膜與基底間的介面特徵,以 Elastic Dection Anaysis (ERDA)和二次離子質譜儀(SIMS)用於 SrTiO3 /LaAlO3 系統來觀測氧的擴散。發現在蒸渡薄膜中,氧的主要供給來自 SrTiO3 基底,而且明顯地氧擴散到 LaAlO3 薄膜上在 500℃ 溫度。又提到 LaAlO3 在 SrTiO3 基底上時,氧的擴散比 SrTiO3 在 LaAlO3 基底上時慢。他的結論中提到基底是氧的顯著來源。在氧化物薄膜成長中,在氧的平衡下,會產生氧的缺陷,造成基底導電性,甚至磁性發生改變。

(c) Guus Rijnders 主講 Functional interfaces in oxide hetero structures by atomically controlled pulsed laser deposition。
複雜氧化物材料在電子元件中扮演著重要的腳色,乃因它們顯示廣泛的功能性質,諸如高介電係數,壓電性與鐵電性,超導性,巨磁阻和鐵磁性。許多這類現象發生在氧化物,而這些氧化物的晶格常數與另一種氧化物晶格常數匹配在幾個的百分比,這就能製成異種磊晶結構,以致有許多自由度,作成奇異功能的可能。無論如何, 一全新的奈米元件出現,氧化物介面之奇異功能性質,介面修改電子關聯,控制材料的電子行為,而且介面的修改能夠誘發群集電子與磁性之顯著變化。他的演講集中於 SrTiO3-LaAlO3 間的極化介面上電子重構問題,來自這種新型的 electron doping 產生的現象,從超導到磁散射,他都一一地呈現給聽眾看。最後, 他也提到 perovskite 氧化物間的異質介面之未來挑戰的最新發展。

(d) Seisuke Nakashima 主講 Precipitation of ferromagnetic nanoparticles inside transparent glassly femtosecond laser。利用飛秒雷射照射之下,可把奈米金屬顆粒,在空間上選擇性地堆在透明材料內,大部分的情形,這些金屬顆粒是金、銀或其合金作為三度空間的標幟等等,但都未有關於磁奈米顆粒在材料內,磁性功能的局域色散的報導。他報告在透明玻璃材料內部,以光誘發沉積磁奈米顆粒,利用玻璃熔化方法製備鐵離子摻入矽玻璃內,然後以飛秒雷射(λ=775nm)照射玻璃內中樣品做淬火動作,此一樣品的吸收譜的高峰約在400nm,此相應於奈米顆粒的局域表面電漿子吸收。利用 TEM,看到奈米顆粒 dispersed 在玻璃樣品被照射部份,猜測鐵的高磁化密度是來自於金屬鐵的奈米顆粒,若 annealed glass 未以飛秒雷射照射,其磁性與光學性質發現沒有改變。

(e) Richard Haglund 主講 Dynamics of Exciton – Plasmon Coupling in ZnO–MgO –Metal heterostructures。Exciton – Plasmon Coupling 模型是一粒子與凝態材料內的群集激發間的基本相互作用。利用 time-resolved photoluminescence(PL)及 both broad –band 與 frequency-degenerate Pump-Probe(PP) spectroscopy 觀測 band-edge exciton 和 visible luminescence

centers and plasmonic nanostructures 間的耦合,要探討的系統是薄膜異質結構,它由 ZnO 薄膜或量子阱和 plasmonic metal layer 間插入 MgO (改變厚度)分隔。Plasmonic layer 為 nanodisc arrays 或 Au , Ag 或 Al 的粗糙膜。前者是局域表面電漿共振膜主導,而後者是表面電漿極化子(surface Plasmon polariton(SPP))所主導。Au 及 Ag 的 SPP 顯示 band-edge exciton PL 的 Purcell – like 放大,而 vissible luminescence 中心,來自 intrinsie defects,更強地藕合到 Ag LSPR,且顯現 single dipole 及 dipole 天線陣列間藕合之相互間隔的相依性。從 ZnO band – edge 到 SPP 共振之 Peak PL 放大,隨著 MgO 厚度增加,而產生紅移現象。Al LSPR 隨著 disc 直徑的增加,而從 360nm 變化到 550nm,所以原理上應該藕合到 exciton 及 defect luminescene centers,完全端視奈米顆粒的大小。

三、建議

此次參加小型會議,收穫甚多,與那些專家討論,認識新專家。建議年輕的助理教授優先參加小型會議開始,跟自己專業的專家學者有較多時間討論及建立合作的機會。我則想找些專家,能對交大同仁有所幫助。

四、攜帶回國資料

ICPEPA-7 的會議摘要手冊,歡迎有興趣的專業人事借閱。

國科會補助計畫衍生研發成果推廣資料表

日期:2011/01/05

國科會補助計畫	計畫名稱: 超導中渦漩運動和電磁超介質材料奇異特性的研究
	計畫主持人: 楊宗哲
	計畫編號: 98-2112-M-216-001- 學門領域: 超導－理論

無研發成果推廣資料

98 年度專題研究計畫研究成果彙整表

計畫主持人：楊宗哲	計畫編號：98-2112-M-216-001-
計畫名稱：超導中渦漩運動和電磁超介質材料奇異特性的研究	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	3	0	100%	人次	
		博士生	2	0	100%		
		博士後研究員	1	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	15	15	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	2	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	PIERS 2009 international conference serves as Session Organizer or Chairman.

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：■已發表 □未發表之文稿 □撰寫中 □無

專利：□已獲得 ■申請中 □無

技轉：□已技轉 □洽談中 ■無

其他：(以 100 字為限)

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)

Surface plasmon polariton has been made to be able to progate in transmission line for microwave.

For one dimensional photonic crystals, we have digged out very new phenomena and applications.

For superconductors, the vortex motion in superconducting film have found new function.