

李林教授为我国科学事业的发展作出了重要贡献，树立了一代中华女性的崇高风范！

庆贺李林教授七十寿辰

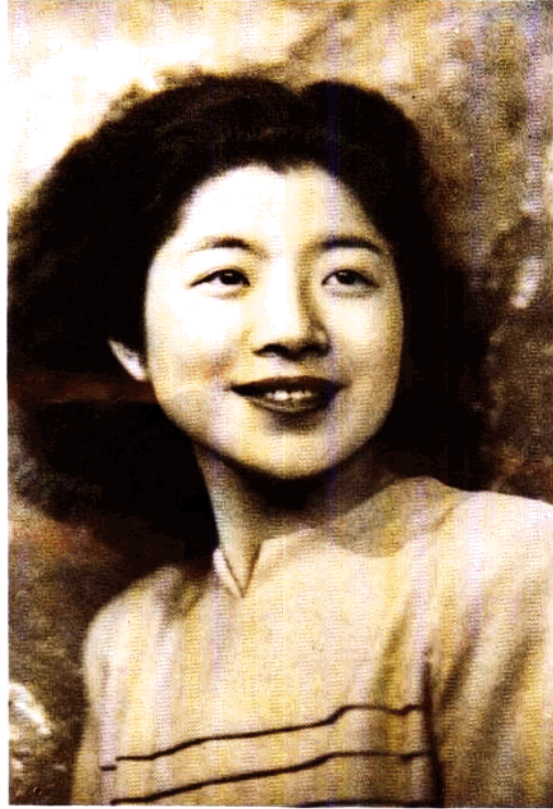
中国科学院物理研究所所长

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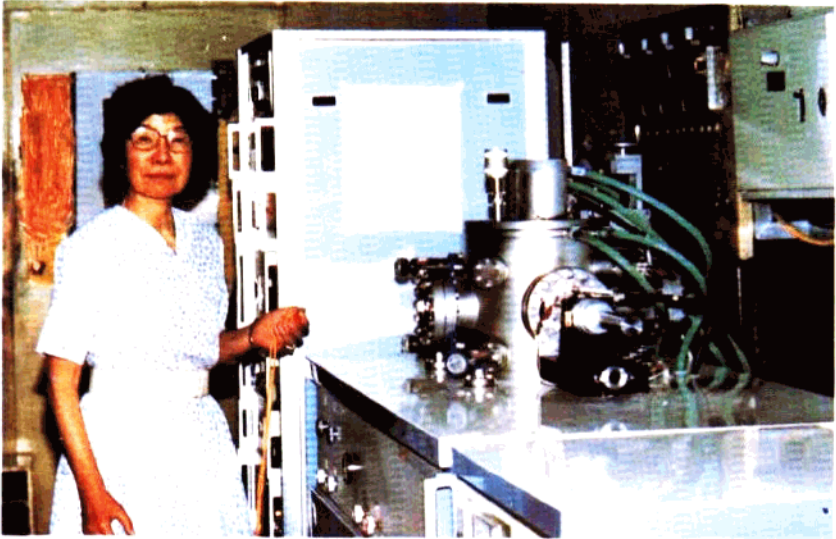
一九九三年六月



1992 年于北京



1946年于英国伦敦



李林教授在溅射高温超导薄膜

序

李林教授，祖籍湖北黄冈，出生于北京书香门第，科学世家。1944年毕业于广西大学，后去英国留学，曾从师于金属位错的发现者 Cottrell 教授。在英国攻读硕士、博士学位期间，研究高纯铝的蠕变与低碳钢的时效硬化。博士论文答辩之后，在巴黎参加了国际会议后即取道苏联返回祖国，投身于新中国的科技事业。

在上海冶金所协助周仁所长研究国家急需的球墨铸铁，1956年获中国科学院自然科学三等奖；研究包头铁矿的含F炉渣对石墨耐火材料的腐蚀获1981年国家自然科学三等奖。在金属物理研究中多有建树，发表了重要论文，建立了电子显微镜实验室，为我国早期电子显微镜研究专家之一。并在1956年赴东京参加第一届亚太电子显微镜学会，为长期的国际交流奠定了基础。

李林教授由于工作需要于1958年调入核工业部，从事有关金属材料的研究。为我国核材料的生产工艺改进、辐照损伤及性能测试分析做了大量的工作，是一位为我国核材料研究的发展做出了重要贡献的无名英雄。1973年以后李林教授从事低温超导研究，并于1978年到物理所从事探索高温超导体研究。她丰富的经验及坚持在第一线从事科学研究的作风对年轻的同事有很大影响，并指导了大批研究生。在很多方面取得了重要成果，特别是在超导薄膜及物理方面。如在中国第一家制备出了临界温度最高的 $A15 Nb_3Ge$ ，这在当时国际上也是为数不多的。系统地研究了 $A15 Nb_3Ge$ 的成相规律和 $Mo-Si$, $Mo-Ge$ 非晶薄膜生长特性和物理性质，发表了多篇重要论文。

1986年高温氧化物超导体发现不久，立刻进行了 $Sr-La-Cu-O$ 薄膜的研制工作，用直流磁控溅射及后热处理法获得了 $T_c=27K$ 的薄膜样品，在中国物理快报上发表了文章，这是国内外发表的最早的文章之一。1987年初发现了液氮温区超导体后，又立即开展了 $Y-Ba-Cu-O$ 薄膜的研制工作，采用射频磁控溅射及后热处理法，用粉末靶，在1987年6月得到 $T_{c0}=82K$ 的液氮温区超导的薄膜，1988年底获得临界电流密度 $J_c=1.34 \times 10^6 A/cm^2$ ， $T_{c0}=90K$ 的薄膜样品，达到了国际先进水平。1989年初开始用原位直流磁控溅射法研制 $YBa_2Cu_3O_7$ 薄膜，使用这种方法不加后热处理，制备出了用于超导器件的高质量外延薄膜，1989年底获得了c轴取向的、重复性比较好的外延单晶薄膜， $J_c=3.4 \times 10^6 A/cm^2$ 。她所领导的研究组在薄膜制备方面一直跟随国际先进水平。1990年开始制备 $YBCO/PBCO$ 多层膜及超晶格，最薄层是一个单胞， T_c 仍可达到43K。

到 1992 年为止, 共发表 30 多篇文章, 并获得 1991 年中国科学院科技进步一等奖和 1992 年国家科技进步二等奖。

李林教授还没有等待得到博士证书, 即急速返回刚刚建立的新中国。她的剑桥大学博士证书一直到文化大革命之后才由英国的朋友带来。几十年来, 李林博士从南到北, 从一个单位转到另一个单位, 服从于祖国的需要。每到一处都留下了丰硕的成果。特别是她坚持严谨治学, 提携年轻学子, 坚持在第一线从事科学研究的风范, 为大家树立了榜样。1980 年她当选为中国科学院学部委员。多年来参加了很多全国青联、全国妇联及政协的工作和国际学术交流活动, 为祖国科学事业的发展及人才的培养作出了重大贡献。为向李林教授学习和庆贺李林教授献身于祖国科学事业四十年所取得的业绩, 特出本文集, 由于编者水平有限, 不当之处欢迎各位指正。

衷心祝愿李林教授身体健康, 为祖国的科学事业作出更大贡献。

超导国家重点实验室

A handwritten signature in black ink, reading '赵忠贤' (Zhao Zhongyuan). The characters are written in a cursive, flowing style.

1993 年 6 月 26 日

PREFACE

Professor Lin Li, originally from Huang-gang, Hubei province was born in Beijing from an academic family. She graduated from Guangxi University in 1944 and then went to England for post graduate studies. She worked with Professor A. Cottrell, the discoverer of dislocation in metals, and in her M. Sc. and Ph. D. thesis, she worked on creep of high purity aluminum and age hardening of low carbon steel respectively. After successfully defended her Ph. D. thesis, she returned home via the Soviet Union and devoted herself to the development of Science in New China.

She joined the Institute of Metallurgy in Shanghai in 1951 and jointly with Professor R. Zhou, she worked on the spheroidal graphite cast iron which was awarded a Natural Science Prize, third class of Academia Sinica and the corrosion of graphite linings by the fluorine containing iron ore of Baotou which was awarded a National Natural Science Prize, third class. All the works she did in that period and later were much needed by the country. She published many important papers on metal physics and established one of the first laboratories on electron microscopy in China. She was among the pioneers on electron microscopy of China and attended the first Asian and Pacific Conference of Electron Microscopy in Tokyo in 1956 which established many long term International links in this important field.

Professor Li moved to the Ministry of Nuclear Industry in 1958 and devoted herself on the study of metals as nuclear materials. She made many important contributions on the research of radiation damage and testing of nuclear materials. She was one of those who played important roles in the development of nuclear materials in this country but was very little known for their contributions. Since 1973, she worked on low temperature superconducting materials, and then in 1978 began the exploration of high temperature superconductivity in the Institute of Physics. She insists on doing experiments herself in the laboratory and her vast experience has had great influence on the younger generations. She and her graduate students have made many important contributions especially in superconducting thin films and

its physics. Her group was the first in China to obtain the highest critical temperature in $\text{Al}_5\text{Nb}_3\text{Ge}$ and this at that time had only been achieved in but a few laboratories in the world. She has also published many important papers on phase rule of $\text{Al}_5\text{Nb}_3\text{Ge}$ as well as the physical properties and growth characteristics of Mo-Si and Mo-Ge amorphous films.

Soon after the discovery of high temperature oxide superconductors in 1986, she began to study the preparation of Sr-La-Ca-O thin films and by DC magnetic sputtering followed by post annealing obtained thin films with a T_c of 27K and this was published in Chinese Physics Letters as one of the first papers of the world in this field. After the discovery of superconducting Y-Ba-Cu-O at liquid nitrogen temperature, her group began to study Y-Ba-Cu-O thin films. The method employed was RF magnetic sputtering a powder target followed by post annealing. With great efforts, her group succeeded in June 1987 to obtain thin films with a T_{c0} in the liquid nitrogen region of 82K and in 1988 obtained films with a $J_c = 1.34 \times 10^6 \text{ A/cm}^2$ and a $T_{c0} = 90\text{K}$. This achievement was in the forefront of studies in this field internationally. At the beginning of 1989, her group used the in-situ DC magnetron sputtering method to prepare the $\text{YBa}_2\text{Cu}_3\text{O}_7$ thin films, no post annealing treatment was necessary, by using this method high quality epitaxial thin films can be prepared and is useful for superconducting electronic device applications. At the end of 1989, her group succeeded in obtaining epitaxial single crystalline thin films with c-axis orientation, the J_c reached $3.4 \times 10^6 \text{ A/cm}^2$ and the reproducibility was good. Her group always followed the trend of international frontier closely. In 1990 her group started to make YBCO/PBCO multilayer and superlattices, the thinnest layer was one single cell and the T_{c0} could still reach 43K.

Up to 1992, her group published over 30 papers in the field of high T_c thin films and was awarded a Prize First class of Progress in Science and Technology of the Chinese Academy of Sciences in 1991 and a National Prize Second class of Progress in Science and Technology 1992.

She returned to the New China just established soon after she successfully defended her

thesis without waiting to get her Ph. D. diploma. This was brought to her by an English friend nearly thirty years after her graduation. She moved from South to North, from one institution to another to follow the need of the country. She made important contributions wherever she worked and whatever field she was asked to work in. She was elected a Member of the Chinese Academy of Sciences in 1980. She is also active socially in the National Organizations of Youth and Women and a member of the Chinese Peoples Political Consultative Conference. She has made great contributions not only to Chinese Science but also in the training of young scientists.

This book is dedicated to Professor Lin LI for the celebration for her 40 years devotion to Chinese science.

Wishing Professor Li good health, wishing that she is to make great contributions to Science for many years to come.

National Laboratory for Superconductivity

A handwritten signature in black ink, reading "Zhong-Kuan Zhao". The signature is written in a cursive, flowing style.

1993.6.26.

我的科学研究活动

我是一名普通的科学工作者，从事研究工作已四十余年。1946至1951年曾在英国剑桥大学学习金属物理专业，并获得了博士学位。回国后到上海中国科学院冶金所任职，进行了球墨铸铁的研究工作，当时我们有三位女科学家一起工作，为此我们获得了“三八红旗手”的称号，这项研究工作在1956年获得了中国科学院自然科学集体三等奖。

1958年我调到北京原子能研究所负责筹建反应堆材料辐照研究室，这是我非常喜爱的专业，但是做实验时要经受较强的放射性物质的侵害，一般不适宜女性工作，我管不了这么多，经常和男同事一起到“热室”工作。所谓“热室”就是有防护层的小屋子，里面放着要实验的放射性物质，人在外面用机械手操作。我就这样和男同事们一起默默无闻地工作了十几年，因为我们的工作当时是不能发表论文的。

那时我的丈夫在上海工作，每年我们只能见几次面，我的女儿很小，跟着她外祖母生活，我们每周相聚一次，我一人住在集体宿舍，在食堂吃饭。虽然我因科研照顾不了家庭，但是我很热爱我的工作，一点也不感到寂寞或苦闷，我和周围的同事相处得很好，所以感觉还是很幸福的。

1976年10月，粉碎了“四人帮”，我们中国重见了天日，这时我已是年过半百了，由于工作的需要我改行研究超导材料。我干一行爱一行，从头学起，经过将近廿年的超导研究工作，我的确热爱这项专业了，特别是1987年开始，发现了在液氮温度超导的钇钡铜氧化物，我们和全世界一样掀起高温超导体研究的热潮。现在四年多已过去了，我们也冷静下来，做深入细致的物理问题研究工作。

近十年来，由于我们国家的政策好，科学技术突飞猛进，我自己的工作也是如此，带了十个研究生，看着他们一个个以优秀的成绩获得学位，我心里乐滋滋的。



简 历

李林, 女, 1923年10月31日生于北京

- 1944年 广西大学机械工程科学系, 学士
- 1948年 英国伯明翰大学冶金系, 硕士
- 1951年 英国剑桥大学冶金和材料科学系, 博士
- 1951—58年 中国科学院上海冶金研究所, 副教授
- 1958—60年 中国科学院原子能研究所, 副教授
- 1960—71年 中国科学院原子能研究所, 教授
- 1972—78年 中国科学院高能物理所, 教授
- 1978— 中国科学院物理研究所, 教授

1980年当选为中国科学院学部委员

BIOGRAPHIC NOTES

- Name:** Lin Li (Anna Ling Tsou)
- Sex:** Female
- Date and Place of Birth:** October 31, 1923, Beijing, China
- Education:** 1944 B.A. Department of Mechanical Engineering Science,
Kwangsi University, Kwangsi, China
- 1948 M.Sc. Department of Metallurgy,
Birmingham University, Birmingham, England
- 1951 Ph.D. Department of Metallurgy and Material Science,
Cambridge University, Cambridge, England
- Positions:** 1951—58 Associate Professor, Institute of Metallurgy, C.A.S, Shanghai
- 1958—60 Associate Professor, Institute of Atomic Energy, C.A.S., Beijing
- 1960—71 Professor, Institute of Atomic Energy, C.A.S., Beijing
- 1972—78 Professor, Institute of High Energy Physics, C.A.S., Beijing
- 1978— Professor, Institute of Physics, C.A.S., Beijing
- Honor:** 1980 elected as a Member of Chinese Academy of Sciences

李林主要论著题录

- 1 **Equi-cohesive Temperature of Polycrystalline Aluminium**
M. Sc. Thesis
- 2 **The Quench Ageing of Iron**
Ph. D. Thesis
- 3 **The Oxide Replica of Iron**
co-author J.Nutting
2nd International Congress of Electron Microscopy, Paris, (1950)
- 4 **Austenite in Low Carbon Iron**
co-authors J.W.Mentor and J.Nutting;
Proc. Phys. Soc. London, 65B, (1952); 305
- 5 **The Heat Treatment of Spheroidal Graphite Iron**
co-authors S.C.Chen and H.Shen
1st Chinese Metallurgical and Metal Physics Society Meeting (1955)
- 6 **Research on Carburized Low Carbon Steel with Small Addition of Boron**
co-author C.B.Kuan
Chinese J. Metals, 1(1956)3
- 7 **The Research on Mo-alloyed Structural Steels with Small Addition of Boron**
co-authors M.W.Chi, et al.
Chinese J. Metals, 1(1956)3
- 8 **The Effect of Small Addition of Boron on Nucleation and Growth of Pearlite in Steel**
co-authors M.W.Chi, et al.
Chinese J. Metals, 2(1957)1
- 9 **The Effect of Small Addition of Boron on the Austenitic Temperature of Low Carbon Alloy Steels**
co-authors S.L.Yu, et al.
Chinese J. Metals, 2(1957)1
- 10 **The Replica Technique for Metallography on Radioactive Materials**
co-author S.F.Sun
J. Science and Technology of Atomic Energy, (1964)8
- 11 **The Effect of Crystal Defects on Superconducting Materials**
《Defects of Solids (Publ.by Nanking University)》, May, (1979)
- 12 **Electron Microscopy in Mineralogy**

Editor, co-authors Zhou J.X., et al.

Geology Press, Beijing (1980)

- 13 **吸气溅射装置(A Getter Sputtering Apparatus)**
合作者: 蒙如玲, 等
低温物理, 2(1980)4; 268
- 14 **Preparation and Analysis of High-Tc Nb-Ge Films**
co-authors B.R.Zhao, P.Zhao, et al.
J. Low Temp. Phys. 45(1981)3/4; 287
- 15 **Preparation and Analysis of High Tc Nb-Ge Films**
co-authors B.R.Zhao, et al.
Physica B, 107(1981)1-3; 651
- 16 **Electron Microscopy Study of Superconducting NbGe Films**
co-authors B.R. Zhao. et al.
Proc. 1st Chinese-Japanese Electron Microscopy Seminar, (1981); 126
- 17 **A Study of Sputtered NbGe Films**
co-authors B.R.Zhao et al.
Chinese Sci. Bull.,27(1982)1; 27
- 18 **A15 Nb₃Ge 超导薄膜的电子显微镜观察(A Preliminary Electron Microscopy of the A15 Nb₃Ge Superconducting Films)**
合作者: 赵柏儒, 杨大宇, 等
低温物理, 4(1982)4; 291
- 19 **多股铌-钛超导线材中亚晶界的透射电镜观察(TEM Study of Microstructures of Nb-Ti Superconducting Wires)**
合作者: 史引焕, 刘维
电子显微学报, 3(1984)4; 42
- 20 **Amorphous Phase Formation of Mo_{1-x}Ge_x, Mo_{1-x}Si_x Films and Their Superconducting Properties**
co-authors Z.X.Zhao, et al.
Chinese Phys. Lett. 1(1984)1; 23
- 21 **The Development of Melt Spinning of Superconducting Alloys**
Invited talk at the 5th National Confer. of High Tc Supercond., (1984)
- 22 **New Evidence of Stabilization of High Tc A15 Nb₃Ge Phase by Nb₅Ge₃**
co-authors B.R.Zhao and J.Gao
Chinese Phys. Lett., 2(1985)2; 53

- 23 **HREM Examination of the Crystallization Process of Amorphous Pd-Cu-Si Alloy**
co-author W.Liu
Chinese J. of Electron Microscopy.
- 24 **Investigation of the Structure of Amorphous and Partially Crystalline Pd-Cu-Si Alloys by High Resolution Electron Microscopy**
co-authors Yang L.Y., et al.
3rd Chinese-Japanese Electron Microscopy Seminar, (1985)
- 25 **A Study by Lattice Image Method on Metallic Alloys**
Invited talk at BCEIA, (1985)
- 26 **Superconducting Materials R & D in China**
Invited talk at International Cryogenic Materials Conference, MIT, Boston, U.S.A., 1985
see also: Advances in Cryogenic Eng. Materials, 32(1985); 1073
- 27 **The Stabilization Effect of (T)Nb₅Ge₃ on A15 Nb₃Ge**
co-author B.R.Zhao
Advances in Cryogenic Eng. Materials, 32(1985); 1079
- 28 **溅射 Nb-Ge 膜中高 Tc A15 相的形成规律(The Formation of High Tc A15 Phase in Sputtered Nb-Ge Films)**
合作者: 赵柏儒, 高炬
中国科学, A(1986)6; 616
- 29 **高速淬火 Hf-V, Zr-V 薄带的 TEM 观察(Electron Microscopy of Melt Spun Hf-V, Zr-V Compounds)**
合作者: 王永刚 co-author Y.G.Wang,
第四次全国电子显微学会议, 6月, 1986年, 包头
另见: 电子显微学报, 5(1986)3; 135
30. **HREM Examination Of the Rapidly Quenched Pd-Si-X Alloys**
co-author C.M.Teng
XIth International Congress on Electron Microscopy, Aug. 31—Sept. 7, Kyoto, Japan, 1986
see also: 《Electron Microscopy 1986》, Vol. 1, 825
- 31 **氧、碳杂质对 B1 结构氮化钒薄膜的 Tc 和电阻率 ρ (T) 的影响(The Effect of Oxygen and Carbon on Tc and ρ (T) of Sputtered B1 Structure VN_x Films)**
合作者: 赵柏儒, 史引唤, 等
低温物理学报, 9(1987)1; 37
- 32 **Pd-Si 系非晶合金的晶化行为(The Crystallization Behavior of Pd-Si Amorphous Alloys)**
合作者: 杨林原

- 33 **Superconductivity of Sr-La-Cu-O Thin Films**
co-authors B.R.Zhao, et al.
Chinese Phys. Lett., 4(1987)5; 233
- 34 **Superconductivity at 89K of Ba-Y-Cu-O Thin Films**
co-authors B.R.Zhao, H.S.Wang, et al.
Chinese Phys. Lett., 4(1987)6; 280
- 35 **Zero Resistance at 91.5K In the Ba-Y-Cu-O Compound System**
co-authors B.R.Zhao, Y.H.Shi, et al.
Chinese Phys. Lett., 4(1987)6; 286
- 36 **Point-contact Tunneling Investigation of the Superconductors in Y-Ba-Cu-O System**
co-authors H.J.Tao, Y.F.Chen, et al.
Chinese Phys. Lett., 4(1987)11; 481
- 37 **Magnetization Measurements of High Tc Superconducting Ba-Y-Cu-O System**
co-authors Y.H.Shi, B.R.Zhao, et al.
Chinese Phys. Lett., 4(1987)11; 485
- 38 **Study of Ba-Y-Cu-O Thin Films with Zero Resistance at LN₂ Region Prepared by Magnetron Sputtering**
co-author B.R.Zhao, H.S.Wang, et al
Chinese Phys. Lett., 4(1987)12; 529
- 39 **High Tc Superconductivity of Ba-Y-Cu Oxide**
co-authors Yin-Huan Shi, et al.
Proc. 18th Conf. on Low Temp Physics, Kyoto, 1987
see also: Japanese J. Appl. Phys. (suppl.), 26(1987)
- 40 **Superconductivity of the Ba-Y-Cu-O System in the Liquid Nitrogen Temperature**
co-authors Zhao Bairu, et al
Proc. 18th. Int. Conf. on Low Temp. Phys., Kyoto, Japanese
see also: Japanese J. Appl. Phys. (Suppl.), 26(1987); 1083
- 41 **Study of Y-Ba-Cu-O High Tc Temperature Superconducting Thin Films**
co-authors J.Q.Zheng, et al
18th Conf. on Low Temp. Physics, Kyoto, (1987), Japanese
see also: Japanese J. Appl. Phys. (Suppl.), 26(1987)3; 2036
- 42 **High Tc Superconductivity of Sr-La-Cu-O and Ba-La-Cu-O Thin Films**
co-authors B.R.Zhao, et al.

Pres. Int. Workshop High Temp. Supercond., Beijing, 29 June-1 July, 1987

see also: Modern Phys. Lett., B1(1987); 177

- 43 **The Effect of Sc on the Superconductivity of Ba-Y-Cu Oxides**
co-authors B.R.Zhao, Y.H.Shi, et al.
Solid State Commun., 63(1987)5; 409
- 44 **The Superconductivity, Structure and Microstructure of Ba-Y-Cu Oxide**
co-authors Y.H.Shi, H.S.Wang, et al.
Solid State Commun., 63(1987)7; 641
- 45 **The Structure and Morphology of High-Tc Ba-Y-Cu Oxide Superconductor**
co-authors Y.H.Shi, et al.
Solid State Commun., 63(1987)7; 661
- 46 **取向 Ba-Y-Cu-O 薄膜的显微结构与电流密度(Microstructure and Critical Current of Orientated YBaCuO Thin Films)**
合作者: 王会生, 赵柏儒, 等
科学通报, (1988)15; 1134
英译文见: Chinese Sci. Bull., 34(1989)5; 370
- 47 **High Tc Y-Ba-Cu-O Thin Films by Ion Beam Sputtering**
co-authors J.Gao, Y.Z.Zhang, et al.
Appl. Phys. Lett., 53(1988)26; 2675
- 48 **Morphology and Structure of High Tc BaYCuO Thin Films**
co-authors H.S.Wang, B.R.Zhao, et al.
Chinese Phys. Lett., 5(1988)1; 5
- 49 **Theoretical Investigation on Composition and Pressure Dependences of Superconductivity for Various Oxide Systems**
co-authors G.M.Zhao, R.L.Wang, et al.
Chinese Phys. Lett., 5(1988)4; 165
- 50 **Some Remarkable Behavior below 125K in High Tc Superconductors**
co-authors G.M.Zhao, R.L.Wang, et al.
Chinese Phys. Lett., 5(1988)5; 209
- 51 **The Study of Critical Current in YBaCuO Thin Films**
co-authors C.W.Yuan, B.R.Zhao, et al.
J. Appl. Phys., 64(1988)8; 4091
- 52 **Superconducting and Normal State Properties of YBaCuO Thin Films Sputtered on ZrO₂ Substrates and Their Morphology**