徐祖耀文选

The Selected Works of T. Y. Hsu (Xu Zuyao)

Edited by

School of Materials Science and Engineering, Shanghai Jiao Tong University

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上海交通大学
材料科学与工程学院 编

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内 容 简 介

徐祖耀先生是中国科学院院士，上海交通大学教授，著名材料科学家。本文选由徐祖耀先生迄今为止发表的数百篇学术研究成果论文中精选而成。书中全面、系统地反映了徐祖耀先生半个多世纪以来在马氏体相变、贝氏体相变、形状记忆材料、材料热力学等领域的科研活动和学术成就，读者也可从一个侧面领略到他勤奋治学和勇于实践的精神。

本书可供从事材料科学、金属、物理、航空、航天、机械等研究的科技人员及高等院校相关专业师生参考。

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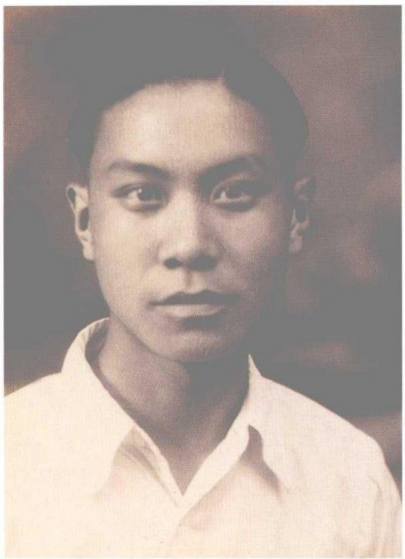
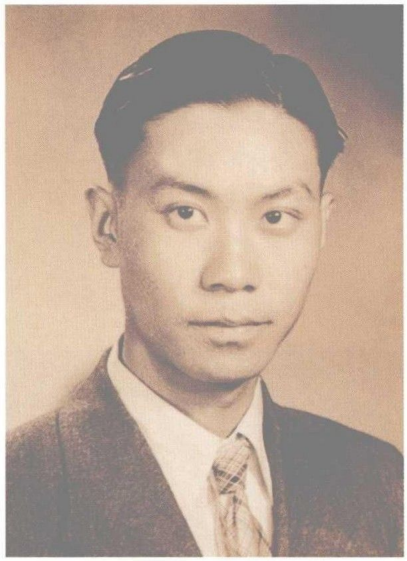
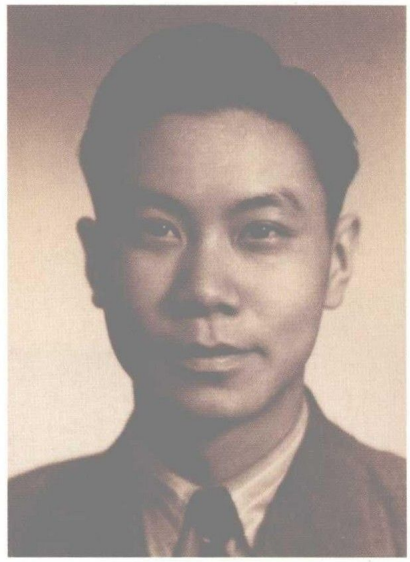


1937-As a student at Xiao-Shi High School in Ningbo, Zhejiang

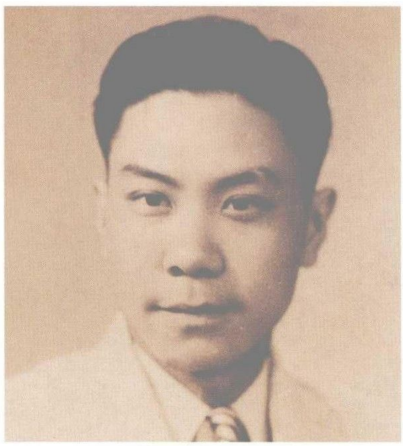


1942-Graduated from Department of Mining and Metallurgy, National Yunnan University in Kunming, Yunnan

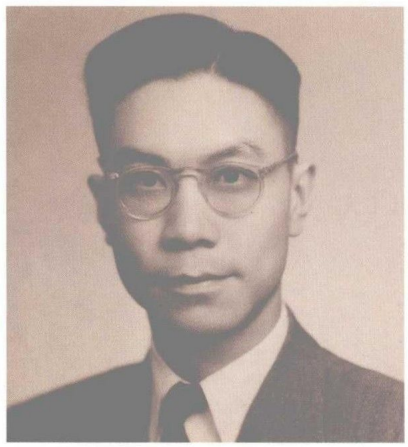


1943-At the Bureau of Materials Research in Zhongqing

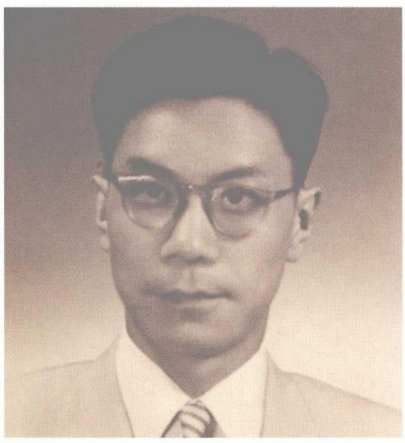
1946-At the Eve of leaving Zhongqing soon after winning the Anti-Japanese War



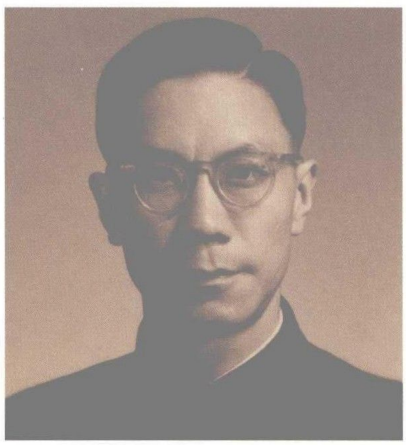
1947-At the Bureau of Materials Research in Nanjing



1949-At Tangshan Jiao Tong University in Tangshan, Hebei



1949-At Beijing University of Iron and Steel Technoloy (now the University of Science and Technology Beijing) in Beijing



1964-At Shanghai Jiao Tong University in Shanghai

1995-As a Member of Chinese Academy of Sciences in Shanghai

May, 1980-Met Prof. Morris Cohen in Shanghai and complimented him with the freshly published book "*Martensitic Transformation and Martensite*"

1982-Met Prof. H. I. Aaronson in Shanghai

1989-With Prof. C. M. Wayman (center) and Prof. K. Shimizu (清水谦一) at the ICOMAT-89 in Sydney, Australia

1989-With Prof. F. E. Fujita（藤田英一） at the ICOMAT-89 in Sydney, Australia

FOREWORD

The Selected Works of T. Y. Hsu (Xu Zuyao), which is compiled by the School of Materials Science and Engineering, Shanghai Jiao Tong University (SJTU) and published by the Science Press in Beijing, is prepared for honoring Professor T. Y. Hsu (Xu Zuyao), an academician (member) of the Chinese Academy of Sciences. In the past 60 years or so, Professor T. Y. Hsu has been devoting himself to research and teaching in the field of materials science and engineering. He has achieved plentiful and substantial successes; 8 treatises and more than 400 papers, authored or co-authored with his colleagues and students, have been published, as listed in Appendix.

For the ease of picking up Professor Hsu's representative essays to be read, being composed of 86 papers carefully selected from his total 143 ones already published in English, the *Selected Works* can clearly show his great attainments in thermodynamics of materials and creative achievements and contributions to materials science and engineering, mainly in martensitic transformation, bainitic transformation, shape memory materials and so forth. Professor Hsu revealed that there exists diffusion of interstitial atoms or ions in diffusionless martensitic transformation and therefore, he renewed the definition of martensitic transformation. He consummated the thermodynamics of martensitic transformation in ferrous alloys and succeeded in solving a difficult topic on calculating the transformation start temperature M_s in Fe-C alloys. By using Soliton Theory, he deduced and interpreted the relationship between the driving force for transformation and the growth velocity of martensite. He established the thermodynamics of martensitic and bainitic transformations in Cu-based alloys and made evident that bainitic transformation occurs in ceramics as well. He has made great efforts to investigate the martensitic transformation and the associated shape memory effect in Ni-Ti, Cu-Zn-Al, Ni-Al, Fe-Mn-Si based alloys and the ceramics containing ZrO_2. Group Theory has been employed to analyze the symmetry characteristics of martensitic transformation in shape memory alloys and he built a mathematical model for computing the symmetrical distribution of thermoelastic martensites. Then, he extended the application of group theory in the study of crystallographic reversibility and creatively proposed that the necessary requirement for the shape memory effect resulting from martensitic transformation is to obtain single variant of martensite. Based on his theoretical studies, he also developed new types of shape memory materials.

Most of the investigations Professor Hsu has conducted are much industry-orientated, and are very contributory to the development of materials science and the growing of national economy. An important example was that his study on the kinetics of isothermal martensitic transformation in bearing steels substantially improved the dimensional stability of bearings. When his preliminary result was first reported in the proceedings of an international conference, the whole paper was immediately reprinted by a well-known magazine *Industrial Heating*, attracting extraordinary interests from industy. Now it has been transferred into an effective technology in

practice.

Professor Hsu is not only an outstanding and diligent scientist, but also an excellent educationalist. He has constantly given impetus to the education reform. He has long been appealing and pioneering to found a true discipline of materials science and engineering, and to strengthening its basement, insisting on the perfect combination of both aspects and the continual extension of the teaching and research fields. He was the first-term head of the Department of Materials Science and Engineering, Shanghai Jiao Tong University and an advisor of the Department of Metallurgy, Shanghai University of Technology (now Shanghai University). He has been teaching in universities for over 50 years, successively in Tangshan Jiao Tong University, Beijing University of Iron and Steel Technology (now the University of Science and Technology Beijing) and Shanghai Jiao Tong University. His treatises such as *Principles of Physical Metallurgy* (1964), *Thermodynamics of Metallic Materials* (1981, 1983), *An Introduction to Materials Science* (1986), *Theory of Phase Transformation* (1988, 1991, 1999) and *Thermodynamics of Materials* (1999) were and now are still the key text- or reference-books for university undergraduates and postgraduates. His students nowadays are acting everywhere in China and overseas.

Requested by the School of Materials Science and Engineering, SJTU, as one of his ex-students, I am exceedingly pleased to write this **FOREWORD**, acclaiming the publication of the *Selected Works* and expressing my sincere admiration and respect to Professor Hsu. Besides, I would also like to thank Professor Hsu for his constant concerns for the development of science and technology and of the local economy in Shanghai. Finally, on behalf of my own, I do appreciate the institutions and individuals who have contributed to the success of the issue.

(Xu Kuangdi)
Mayor of Shanghai
Professor of Shanghai University
Academecian (Member) of the Chinese Academy of Engineering
September 6, 2000

序

中国科学院院士徐祖耀教授近60年来潜心教学科研，成果迭出，著作等身，桃李满天下。徐教授先后出版了8部专著和400余篇中、英文论文，见本书附录。为便于他海内外的同行、同事、朋友和学生们阅读其代表性论文，由上海交通大学材料科学与工程学院编纂《徐祖耀文选》，并由科学出版社出版。

文选中86篇论文选自徐教授143篇英文论文，集中反映他在材料热力学方面的高深造诣，和马氏体相变、贝氏体相变、形状记忆合金等方面的系统性和创造性研究成果。例如，他揭示了无扩散的马氏体相变中存在间隙原子（或离子）的扩散，由此重新定义了马氏体相变；完善了铁基合金马氏体相变热力学，解决了Fe-C合金相变开始温度计算的难题；以孤立子理论演算和阐释了相变驱动力与马氏体长大速率之间的关系；创建了铜基合金马氏体相变及贝氏体相变热力学；论证了陶瓷中存在贝氏体相变等。他对Ni-Ti，Cu-Zn-Al，Ni-Al，Fe-Mn-Si基合金及含ZrO_2陶瓷材料的马氏体相变和形状记忆效应进行了深入的研究。他以群论研究了形状记忆合金马氏体相变的对称性，建立了计算热弹性马氏体对称分布的数学模型。随后，他又将群论推广应用到晶体学可逆性研究，创造性地提出了由马氏体相变产生形状记忆效应的条件是获得单变体马氏体，并基于理论研究开发了新型的形状记忆材料。

他的大部分研究都有很强的应用背景。一个重要的示例是，他以轴承钢的等温马氏体相变动力学解决了轴承的尺寸稳定性问题，初步结果经国际会议文集刊登后，立即被美国著名的工业实用型期刊“Industrial Heating”全文转载，引起工业界的极大兴趣和关注。现在，该研究成果已成为一项非常实用的生产技术。

徐教授不仅是一位勤奋的、杰出的材料科学家，又是一位优秀的教育家。他一贯热心教育改革。徐教授曾任上海交通大学材料科学与工程系第一任系主任，上海工业大学（现为上海大学）冶金系顾问。长期以来，他积极倡导建立真正的材料科学与工程学科，坚持科学与工程相结合、加深学科基础和拓宽专业面的方针。他先后执教于唐山工学院、北京钢铁学院、上海交通大学，历经半个多世纪，培养出大批材料科学与工程的高级人才。他撰写的《金属学原理》(1964)、《金属材料热力学》(1981，1983)、《材料科学导论》(1986)、《相变原理》(1988，1991，1999)和《材料热力学》(1999)等专著一直是许多大学的本科生和研究生的主要教学参考书。

受上海交通大学材料科学与工程学院之托，也作为他的一名学生，我荣幸地为文选作序，衷心祝贺《徐祖耀文选》的出版，并表达我对徐祖耀教授由衷的尊敬。此外，我也感谢他长期以来一贯对上海市科学技术和地区经济的关注。最后，我以个人的名义向为文选出版做出贡献的团体和个人表示真诚的谢意！

上海市市长
上海大学教授
中国工程院院士

徐匡迪

2000年9月6日

MAIN ACADEMIC AWARDS RECEIVED AND ACADEMIC EXCHANGE ACTIVITIES OF PROFESSOR T. Y. HSU (XU ZUYAO)

Owing to his great contributions, Professor Hsu was awarded the *National Natural Science Prize* in 1987 and the *National Prize of Progress in Science and Technology* in 1999. He was also awarded the *Prizes of Progress in Science and Technology* by the National Commission of Education in 1986, 1987, 1988 and the Ministry of Education (formerly the National Comission of Education) in 1998. Due to his outstanding achievements, Professor Hsu was honorably awarded the *Progress in Science and Technology Prize* by the Ho Leung Ho Lee Foundation in 2000.

Professor Hsu has often been taking part in the international academic exchange very vividly. He was a member (1983—1999) and now is an honorary member of the *International Advisory Committee of Martensitic Transformations*, and has been a member of the *International Committee of Bainite* since 1986. He has also been the member of the Advisory Editorial Board of the international journals *Materials Characterization* (formerly *Metallography*) since 1983 and *ISIJ, International* since 1996.

Professor Hsu was a guest professor at the Katholieke Universiteit Leuven, Belgium. He was invited to visit and to deliver lectures at many famous universities such as the Carnegie-Mellon, Purdue, Connecticut, Florida International and Virginia Universities, Colorado School of Mines, the Research Laboratory of the United States Steel Corporation and the Research and Development of the Teledyne Allac in the U. S., the Technische Universität Berlin, the Ruhr-Universität Bochum and the GKSS-Forschungszentrum Geesthacht GmbH in Germany, the Tokyo, Kyoto, Osaka, Nagoya, Tsukuba, Waseda and Konan Universities in Japan, the National University and Nanyang University in Singapore. He was an honorary professor of the City University Hong Kong where he started joint research in 1996. He has also kept collaboration with the Wollongon University in Australia. He has been frequently invited at international conferences as the invited speaker, the keynote addresser, the member of the advisory or organizing committee and the session chair. Recently in 2000, he was invited to visit Taiwan, Chiao Tung, Tsing Hua, Tatung and Feng Chia Universities and to offer four lectures in Taiwan, making great efforts to promote the exchange of learning and the friendship among the people across the Strait.

徐祖耀院士主要学术成就所获奖项与学术交流

徐祖耀教授的“马氏体相变研究”获1987年国家自然科学奖三等奖；《相变原理》专著获1999年国家科技进步奖（著作类）三等奖；“马氏体相变热力学研究”获1986年国家教委科技进步二等奖；“形状记忆合金研究”获1987年国家教委科技进步一等奖；“贝氏体相变热力学及机制研究”获1988年国家教委科技进步二等奖；《相变原理》获1998年教育部科技进步奖（著作类）一等奖。由于他对材料科学和技术的杰出贡献，荣获2000年何梁何利基金科学与技术进步奖。

徐教授积极参与国际学术交流。他曾任比利时Leuven大学客座教授，马氏体相变国际顾问委员会委员，国际贝氏体相变委员会委员。现任马氏体相变国际顾问委员会名誉委员，国际“材料表征学报”（Materials Characterization，前称Metallography）顾问编委和“日本钢铁学会会刊”国际版（ISIJ，International）顾问编委。他曾应邀访问美国Carnegie-Mellon大学、Purdue大学、Connecticut大学、Florida国际大学、Virginia大学、Colorado School of Mines、联邦钢公司研究所和Teledyne Allac公司，德国Berlin工业大学、GKSS研究所，日本东京大学、京都大学、大阪大学、名古屋大学、筑波大学、早稻田大学、甲南大学，新加坡国立大学、南洋大学等并作学术报告以及和澳大利亚Wollongon大学进行合作研究。他曾多次参加国际学术会议，任特邀报告人、主题报告人、顾问委员会成员、组织委员会成员和会议主席，为国际学术交流做出了很大贡献。他曾任香港城市大学名誉教授，并与该校从1996年开始进行合作研究。2000年，他还应邀访问台湾大学、新竹交通大学和清华大学，以及大同大学和逢甲大学等，并作了四场学术报告，为增进海峡两岸同胞间的学术交流和友谊作出了积极贡献。

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