LITERATURE REVIEW ON SUPERCONDUCTIVITY

BY

IRUTHAYAM MICHAEL

A RESEARCH REPORT SUBMITED FOR PARTIAL FULFILMENT OF THE SPECIAL DEGREE COURSE

IN

PHYSICS

FACULTY OF SCIENCE EASTERN UNIVERSITY, SRILANKA

JULY 1998

pellen On

SUPERVISOR AND HEAD / PHYSICS DR.N.PATHMANATHAN DEPARTMENT OF PHYSICS-EASTERN UNIVERSITY SRILANKA.

CO-SUPER VISOR DR.J.C.N.RAJENDRA DÉPARMENT OF PHYSICS EASTERN UNIVERSITY SRILANKA.

DATE: 10.07.1998

DATE . 10. 07.1998 .





CONTENTS

CHAI	CHAPTER 1			
	INT	RODUCTION	01	
CHAI	PTER	2		
	PHYSICAL PROPERTIES OF SUPERCONDUCTORS			
	2.1	Zero Resistance	03	
	2.2	Meissner Effect	04	
	2.3	Type I And Type II Superconductors	08	
	2,4	Specific Heat	09	
	2.5	Penetration Depth	12	
	2.6	Coherence Length	14	
	2.7	Surface and Free Energy	15	
	2.8	Critical Magnetic Field	17	
		2.8.1 Critical Magnetic Field Of Type I Superconductors	17	
		2.8.2 Critical Magnetic Field Of Type II Superconductors	19	
	2.9.	Magnetization of Superconductors	20	
CHAI	PTER	3		
		ICATIONS OF SUPERCONDUCTORS	22	
	3.1	Superconducting Cables & Wires	24	
	3.2	Superconducting Magnets	26	
		3.2.1 Superconducting Magnet in a particle Accelerators	27	
		3.2.2 Superconducting Magnetic Energy Storage (SMES)	28	
		3.2.3 Magnetic Resonance Imaging (MRT)	28	
		3.2.4 Magnetic Levitated Trains	29	
	3.3	Superconducting Electronics	31	
	3,4	Superconducting Quantum Interference Device (SQUID)	32	
		3.4.1 Direct Current SQUID	32	
		3.4.2 SQUID Based Instruments	33	
		3.4.2.1 SQUID Flux Transformer	34	
		3.4.2.2 · SQUID Gradiometer	34	
-		3.4.2.3 SQUID in Medical Diagnosis	34	
		3.4.2.4 SQUID in Fundamental Science	36	
CITAT	רויזיזינ	4		
CHAI		A RATURE REVIEW ON RESEARCH ARTICLES	38	
LITENATORE REVIEW ON RESEARCH ARTICLES				
	4.1	Bulk Superconductivity at 120K in the Tl-Ca/Ba-Cu-O System	38	
	4.2	A New Age for Type II Superconductors	41	
	4.3	Superconductivity Enhanced By Hg Fission	44	

i

	4.4		ort Properties governed by Surface barriers in CaCu ₂ O ₈	47	
СНАР	TER 5				
CIIM			REVIEW ON RESEARCH PAPERS	51	
	5.1	in Bi-Pl	esistivity Superconducting Transition at 120 K b-Sr-Ca-Cu-O System	51	
	5.2 5.3	110 K A New	Superconductivity in crystallized Bi-Sr-Ca-Cu-O glasss Superconducting Material in a Y-Ba-Cu-O and	54	
		Bi-Ca-	Sr-Cu-O Mixed System	57	
	5.4	Effect of Ni substitution on T _c in the (Bi,Pb)-Sr-Ca-Cu-O System			
	5.5		conductivity in the Bi ₂ (Ca,Sr) _{n+1} Cu _n O _{2n+4} (n=1, 2 or 3) : Synthesis, Characterization and Mechanism	64	
CHAF	TER 6	5			
CILI II			REVIEW ON RESEARCH ABSTRACTS	69	
	6.1		um Conductor Development	69	
		6.1.2	Processing of TI-1223 tapes by Partial Melting Optimization of Superconducting Transition Temperature in the TI-2223 and TI-1223 phases via adjusting Chemical	69	
			Composition and Processing	69	
		6.1.3	Development of Long Length TI-1223 Conductors	69	
		6.1.4	TI-Ba-Ca-Cu-O High Temperature Superconducting Thin Films and Passive Microwave Devices	70	
	6.2	Condu	uctor Development	70	
		6.2.1	Development of HTS conductors and coils for Electric Power Applications	70	
		6.2.2	Development of Bi ₂ Sr ₂ CaCu ₂ O _y HTS conductors and coils for High Field Generation	70	
-		6.2.3	Controlled Process of Ag-clad Bi-based Superconducting tapes	71	
		6.2.4	$Bi_2Sr_2CaCu_2O_x$ conductor preparation for insert coils	71	
			in 20T Magnets	71	
		6.2.5	Recent advances in HTS composite Superconductors	72	
		6.2.6	Optimization of the fabrication Process of Bi-2223 tapes	72	
		6.2.7	Alternative sheath Materials for Bi – 2223	12	
		6.2.8	Fabrication and properties of Superconducting	72	
		620	AgNiMg and AgBi-2212 wires Critical Current anisotropy and effective texture	12	
		6.2.9	in BSCCO phase conductors	73	
			III DONON DIIMON NOTIONNOIN	C1207	

e			
6.3	Appli	cations And Conductor Development	73
	6.3.1	A high temperature Superconductor high voltage Generator	73
	6.3.2	wire and tape during Mechanical Deformation	73
	6.3.3 6.3.4	fabrication of Bi- based single and multifilament tape	74
	0.5.7	multifilamentary Bi-Superconducting tapes	74
6.4	Kinet	ics, Phase equilibrium and Phase development	
	6.4.1	development in Ag/Bi-2223 composite conductors	ure 75
	6.4.2	control of Phase Chemistry	75
	6.4.3	Effect of sintering periods on the pining force, activation energy and microstructure of High-T _c Superconducting Bi-(Pb)-Sr-Ca-Cu-O Tapes	75
6.5	Pinning and YBCO conductor		
	6.5.1 6.5.2	Flux Pinning and Dissipation in high T _c Superconductors The use of Phase Diagrams for the Engineering of Flux	76
	6.5.3	Pinning Centers in BSCCO ceramics Flux Pinning enhancement In Melt processed YBa ₂ Cu ₃ O ₇ -	76
	6.5.4	through rare earth ion substitutions Microstructure property relationships in epitaxial	76
	6.5.5	YBa ₂ Cu ₂ O _{7-d} thin films Distinctive Microstructure of YBa ₂ Cu ₃ O _{7-d} /Pt or CeO ₂ Superconductor produced by new polycrystalline	77
	6.5.6	seeding Method Microstructure development in isothermally melt-	77
	6.5.7	textured Y-Ba-Cu-O Superconductors Reduced oxygen pressure melt processing of	77
	6.5.8	YBa ₂ Cu ₃ O _x /Ag-Pd wires TEM investigation of melt processed YBa ₂ Cu ₃ O _{7-Y} doped	78
		with Y_2BaCuO_5 and PtO_2	78
6.6	Proce	ssing	78
	6.6.1 6.6.2	Hot rolling and hot compressing treatments of Y123 and Bi2223 bulks Magneto-Optic Imaging of high Tc single crystals	78
		revealing flux front instabilities and macro-turbulence	79

	6.6.3	Bi-based 2223 Superconducting ceramics prepared by the glassy "Matrix" precursor method	79
	6.6.4		79
	6.6.5		80
	6.6.6	Hot rolling effect on the Critical Current Density improvement of the Ag-sheathed Bi-2223 tape	80
	6.6.7	Chemical composition, Microstructure and Physical Properties of magnetically melt-textured bulk	00
		Bi ₂ Sr ₂ Ca _{0.8} Dy _{0.2} Cu ₂ O _{8-Y} Superconducting ceramics	80
CONCLU	USION		81

8

 ϵ

19.9

ŝ

•

REFERENCE

82