Particle Induced Electron Emission II

With Contributions by

D. Hasselkamp

H. Rothard, K.-O. Groeneveld, J. Kemmler

P. Varga, H. Winter

With 90 Figures

Springer-Verlag Berlin Heidelberg New York London Paris Tokyo Hong Kong Barcelona Budapest

Contents

Kinetic Electron Emission

			aces Under Ion Bombardment				
By			<i>np</i> (With 31 Figures)	1			
1.							
2.	Definitions and Basic Quantities						
3.	Experiment						
	3.1	Exper	imental Conditions	4			
		3.1.1	Target Preparation	5			
		3.1.2	Target Characterization	6			
	3.2	rement of the Total Electron Yield	8				
		3.2.1	The Quotient Method	8			
		3.2.2	The Ion-Electron-Converter	12			
	3.3	Measu	rement of Energy Spectra of Emitted Electrons	14			
	3.4	Measu	rement of the Angular Distribution	18			
4.	Theo	Theory					
	4.1	Gener	al Considerations	19			
		4.1.1	Generation of Secondary Electrons	19			
		4.1.2	The Diffusion Process	21			
		4.1.3	Penetration of the Surface Barrier	22			
	4.2	2 Summary of Main Theoretical Results					
	4.3	Specia	l Effects in Electron Emission	30			
		4.3.1	Recoil Ionization	30			
		4.3.2	One-Electron Plasmon Decay	31			
		4.3.3	Electron Loss from the Projectile	32			
		4.3.4	The Molecular Effect	33			
		4.3.5	Auger-Electron Emission	35			
		4.3.6	The Binary Encounter Peak	35			
5.	Summary of Typical Results						
	5.1 Summary of Experimental Work						
	in the Period from 1968 to 1990						
	5.2 Energy Dependence of Total Yields from Metal Targets						
	at Normal Incidence		mal Incidence	36			
		5.2.1	Positive Ion Impact	42			
		5.2.2	Relation of Yields to the Inelastic Stopping Power	44			
		5.2.3	Impact by Neutral and Negative Particles	48			
		5.2.4	Impact by Molecular Projectiles	51			
		5.2.5	Cluster Impact	53			

VII

	5.3	Dependence of the Total Yields		
		on the Projectile-Target-Combination	53	
	5.4	The Total Yield as a Function of the Angle of Incidence .	56	
	5.5	The Angular Distribution of Emitted Electrons	58	
	5.6	Energy Spectra of Emitted Electrons		
		from Clean Metal Surfaces	58	
	5.7	Non–Metal Targets	65	
		5.7.1 Semi-Conducting Materials	65	
		5.7.2 Insulating Targets	66	
	5.8	Influence of Surface Layers	69	
	5.9	Impact by Multiply-Charged Ions	71	
	5.10	Temperature Dependence	74	
	5.11	Emission of Polarized Electrons	74	
6.		ied Aspects of Ion–Induced Electron Emission	75	
7.	Sum	nary and Outlook	80	
Re	References			

Kinetic Electron Emission from Ion Penetration of Thin Foils in Relation to the Pre-Equilibrium of Charge Distributions

By	H. Ro	othard, K.O. Groeneveld and J. Kemmler			
(W	ith 20) Figures)	97		
1.	Intro	duction	97		
2.	Forward and Backward Electron Yields				
	in the Charge Equilibrium				
	2.1	Proportionality Between Secondary Electron Yields			
		and Stopping Power	100		
	2.2	Forward to Backward Secondary Electron Yield Ratio	104		
	2.3	Projectile Dependence of Electron Yields			
		and the Relation to the Effective Near-Surface Energy Loss			
		for the Projectiles	106		
3.	Electron Energy and Angular Distributions				
-	in the Charge Equilibrium				
	3.1	Electron Spectra as a Function of the Emission Angle	109		
	3.2	Electron Angular Distributions: Refraction of Electrons	113		
	3.3	Dependence of Electron Spectra			
		on the Surface Coverage with Adsorbates	116		
	3.4	Molecular Effects	120		
4.	Pre-J	Equilibrium Electron Yields	122		
	4.1	Electron Yields as a Probe			
		of Pre-Equilibrium Stopping Power	122		
	4.2	Electron Emission from Molecular Ion Impact	126		
5.	Pre-	Equilibrium Electron Spectra: Convoy Electrons	129		
	5.1	The Four-Step-Model for Electron Emission:			
		Preparation-Production-Transport-Transmission	130		
	5.2	Application to Convoy Electron Emission	134		

				$\begin{array}{c} 141 \\ 142 \end{array}$
Slo	w Pai	ticle-In	duced Electron Emission from Solid Surfaces	
By	P. Vc	ırga anı	d H. Winter (With 39 Figures)	149
1.			1	149
2.	Expe	erimenta	al Techniques for Investigation of sPIE	151
	2.1	Prepa	ration of Slow Particle Beams	152
	2.2	Target	Preparation	154
	2.3	Detect	tion of Reaction Products	155
	2.4	Measu	rement of Electron Emission Yields	155
	2.5	Measu	rement of Ejected Electron Energy Distributions	156
	2.6	Measu	rement of Electron Emission Statistics	157
3.	Revi	ew on F	Potential Electron Emission Processes	157
	3.1	Model	s for Potential Electron Emission	158
	3.2	Exper	imental Results on PE – Total Electron Yields	166
		3.2.1	Singly Charged Projectiles	167
		3.2.2	Excited Neutral Projectiles (Metastable Atoms)	169
		3.2.3	Doubly Charged Projectiles	169
		3.2.4	Multicharged Projectiles	171
	3.3	Exper	imental Results on PE –	
		Electr	on Energy Distribution	175
		3.3.1	Impact of Metastable Atoms	175
		3.3.2	Impact of Ions	176
	3.4		imental Results on PE –	
		Electro	on Emission Statistics	187
4.			e-Induced Electron Emission	
	at the Kinetic Threshold			196
	4.1		recise Threshold of Kinetic Emission	197
	4.2		e Interdependence of PE and KE	198
	4.3		s of Projectile Shielding	
		in Slov	v Particle-Induced Kinetic Emission	201
			and Outlook	208
			•••••••••••••••••••••••••••••••••••••••	209
Lis	t of A	bbrevia	tions	214
Sul	oject]	[ndex		215