

Contents

1. Introduction	1
2. Film Deposition	9
2.1 Plasma Polymer Thin Films	9
2.1.1 Organic Thin Films	9
2.1.2 Plasma Polymerization	10
2.1.3 Fabrication and Properties of Thin Plasma Polymer Films as a Matrix Material for Nanoparticles	14
2.2 Deposition of Polymer Thin Films with Embedded Metal Nanoparticles	31
2.2.1 Embedding Metal Nanoparticles in Polymer Films	31
2.2.2 Plasma Polymer with Embedded Metal Nanoparticles	34
3. Nanostructure	43
3.1 Characterizing Nanostructure	43
3.1.1 Nanostructural Analysis	43
3.1.2 Sample Preparation	45
3.1.3 Determination of Particle Geometry	46
3.2 Particle Size and Shape Distribution of Embedded Metal Nanoparticles	48
3.2.1 Particle Size and Shape Distributions in the Lateral Direction	48
3.2.2 Particle Size and Shape Distribution in the Vertical Direction	64
3.2.3 Three-Dimensional Reconstruction of Particle Geometry	68
3.3 Surfaces and Intermediate Layers	70
3.3.1 Crystal Structure of Embedded Particles	70
3.3.2 Intermediate Layers	72
3.3.3 Film Surface	73
4. Nanostructural Changes	77
4.1 Nanostructural Changes in Embedded Nanoparticles	77
4.1.1 Overview	77
4.1.2 Atomic Diffusion and Ostwald Ripening	79

4.1.3	Coalescence and Recrystallization	83
4.1.4	Migration of Embedded Metal Particles	85
4.1.5	Chemical Changes and Particle Oxidation	86
4.1.6	Melting Point Depression in Nanoparticles	87
4.2	Thermal Treatment of Plasma Polymer Films with Embedded Nanoparticles	89
4.2.1	Change in Particle Size and Shape Distribution	89
4.2.2	Particle Oxidation	99
4.3	Laser Irradiation	102
4.4	Electron Irradiation	106
4.4.1	Overview	106
4.4.2	Electron Irradiation to Initiate Particle Oxidation	108
4.4.3	Electron Irradiation and Simultaneous Thermal Treatment to Initiate Coalescence and Reshaping	113
4.4.4	Electron-Beam-Initiated Coalescence	118
4.4.5	Electron Beam Lithography	121
4.5	Nanostructural Changes Without Thermal Treatment	126
5.	Electronic Properties	129
5.1	Electronic Properties of Insulator Films with Embedded Metal Nanoparticles	129
5.2	D.C. Conductivity of Plasma Polymer Films with Embedded Metal Particles	136
5.2.1	Sample Preparation	136
5.2.2	D.C. Conductivity	137
5.2.3	Temperature Dependence of D.C. Conductivity	141
5.2.4	Nanostructure and D.C. Conductivity	147
6.	Nanostructure and Optical Properties	149
6.1	Optical Properties of Polymer Films with Embedded Metal Particles	149
6.1.1	Optical Plasma Resonance Absorption of Embedded Metal Nanoparticles	149
6.1.2	Experimental Optical Properties of as-Deposited Films	152
6.1.3	Changes in Optical Properties Due to Thermal Treatment	157
6.2	Optical Calculations	165
6.2.1	Modelling Approaches and Dielectric Functions	165
6.2.2	Calculations in the Exact Approach	168
6.2.3	Calculations with Effective Medium Theories	173
6.2.4	Calculational Results	180
6.3	Correlation of Nanostructure with Optical Properties	193
	References	199

Polymer Films with Embedded Metal Nanoparticles

Heilmann, A.

2003, X, 218 p., Hardcover

ISBN: 978-3-540-43151-0