Contents

List of Symbols **IV**

1 Introduction **1**

2 Geometric and Spin–Transport Magnetoresistance Effects in Sensor Applications **3**

2.1 Magnetic Field Sensors 3

2.2 Magnetoresistance Effects: An Overview 5

2.2.1 Anisotropic Magnetoresistance Effect 5

2.2.2 Giant Magnetoresistance Effect 5

2.2.3 Tunneling Magnetoresistance Effect 7

2.2.4 Hall Effect 7

2.3 The EMR Effect: Physical Origin 9

2.3.1 Diffusive Transport in Hybrid Structures 10

2.3.2 EMR Device Configurations 11

3 Transport in Semiconductor–Metal Hybrid Structures in a Magnetic Field: Modeling and Finite Element Method 20

3.1 Two-Dimensional Model 20

3.2 Finite Element Method 23

3.2.1 Variational Principle 24

3.2.2 Numerical Integration 27

3.3 Potential and Current Distributions 34

3.4 Modeling the Contact Resistance 38

4 Influence of Material Parameters and of Geometry on the EMR Effect 42

4.1 Influence of Metal Conductivity 42

4.2 Influence of Carrier Concentration 43

4.3 Influence of Carrier Mobility 47

4.4 Influence of Contact Resistance 50

4.5 Influence of Width–to–Length Ratio 56

4.6 Interplay of EMR and Hall Effects 59

5 Metal–Semiconductor Hybrid Structures for Sensor Applications 65

5.1 Optimization for Read–Head Applications 65

5.1.1 Separate Optimization of Mobility and Geometry 67

5.1.2 Combined Optimization of Mobility and Geometry 71

5.2 Inhomogeneous Fields 75

6 Conclusion and Outlook **81**

Acknowledgments **84**

Bibliography **85**