Book Review

Gold Chemistry. Applications and Future Directions in the Life Sciences. Edited by Fabian Mohr (Wiley-Interscience, 2009) 408 pp., ISBN: 9783527320868 $215

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Gold has existed for centuries; however, the importance of this metal in chemistry has become evident with the exponential increase in the number of gold-centered publications over the last three decades. In almost all of the chemistry journals, at least one research article on gold chemistry is published in every issue. The chemistry of this element encompasses all disciplines of chemistry, from organic, inorganic, physical, and theoretical to materials sciences and medicine. “Gold Chemistry. Applications and Future Directions in the Life Sciences,” edited by Fabian Mohr, summarizes the most active areas of research in gold chemistry. Mohr has organized the book into two sections, each containing four chapters. The first section is devoted to the new chemistry of gold, while the second section covers the current and future applications of gold.

Chapter one, written by John P. Fackler, Jr., focuses on gold(I) nitrogen coordination complexes. Gold is a soft metal and typically prefers soft ligands like phosphorus and sulfur over hard ligands which are nitrogen- or oxygen-based. The authors outline the preparation of mono-, poly-, and heteronuclear gold(I) complexes with amidinate, pyrazolate, and guanidinate ligands. An advantage of preparing the gold(I) complexes with nitrogen-ligands which are in poly- or heteronuclear complexes is that the metal ions are in closer proximity than with traditional ligands on gold. Gold-gold interactions are required for luminescence. Gold(I)- nitrogen coordination complexes are used in the preparation of luminescent materials, which is one of many applications discussed.

In the second chapter, Maria Agostina Cinellu covers the chemistry of gold(III) complexes with nitrogen and oxygen ligands. An expansive discussion about the preparation of gold(III) coordination complexes with neutral, anionic, and multidentate ligands is included. The application of these complexes is medicinally based. Several gold(III) complexes with nitrogen ligands are active against human cancer cell lines that are resistant or sensitive to cisplatin. The biological activities of various gold(III) complexes, some of which are more cytotoxic than current drugs, are integrated throughout the chapter. The synthesis of gold(III) complexes with oxygen ligands concludes the chapter. The application of gold(III)-oxygen complexes is also rooted in medicinal chemistry; however, theses complexes may also be used in olefin oxidation.

Chapter three, written by M. Laguna and co-workers, encompasses the preparation of pentafluorophenyl gold complexes. The pentafluorophenyl ligand is important in gold chemistry because it imparts a degree of stabilization to gold. The complex is usually bound through the ipso-carbon of the pentafluorophenyl ligand. This ligand is also important for crystallinity. Several gold complexes have been prepared that are only stable with the pentafluorophenyl ligand. The chapter covers the preparation of pentafluorophenyl gold complexes with the oxidation states of (I), (II), and (III) with various ligands. Heteronuclear-gold complexes are also described. Pentafluorophenyl gold complexes have been used in liquid crystals, gold clusters, luminescent and vapochromic materials, as well as in volatile organic compound detectors.

In the fourth chapter, Peter Schwerdtfeger and Matthias Lein discuss the theoretical chemistry of gold. A concise yet comprehensive explanation of the relativistic effects on gold is provided. Calculations on atomic gold, gold clusters, inorganic, and organometallic complexes, surfaces and the solid state are also covered. The impact of computational chemistry on the field of gold chemistry is enormous. The authors indicate that tremendous progress has been made in this discipline, but there are significant challenges that still remain. As the field of theoretical chemistry of gold develops, the impact will be seen in all disciplines of chemistry.

Chapter five focuses on the luminescence and photophysics of gold complexes. Chi–Ming Che and Siu–Weu Lai discuss the spectroscopic properties of mono-, di-, and polynuclear gold(I) and gold(III) complexes. The authors provide a detailed discus- sion of the electronic properties of gold complexes and their contribution to the luminescent characteristics of these complexes. In addition, a discussion of how solvent, counterions, and protonation among many other environmental influences which impact the luminescent properties of gold complexes is presented.

In chapter six, Michael W. Whitehouse and co-workers describe the preparation of gold complexes that are medicinally relevant. According to the authors, there has been increased interest in gold-based pharmaceuticals in the last few decades. Research into the biochemistry of gold was not heavily pursued until the 1970s, when research was expanded to investigate the use of gold complexes to treat rheumatoid arthritis, HIV, and cancer. This chapter opens with a general discussion of gold chemistry, including the structures of gold complexes, redox chemistry, and mechanisms of ligand exchange. A very detailed section about the preparation of biologically relevant gold complexes ensues. A section is devoted to how gold interacts with proteins, in particular the serum albumin, metallothioneins, glutathione-peroxidase, insulin, ribonuclease, zinc finger proteins, hemoglobin, and mitrochrondrial thioredoxin reductase. The physiological and cellular biochemistry of gold complexes is also included. Gold(I)-based drugs are usually rapidly metabolized and are more than likely prodrugs in the human body. The authors provide a detailed account of what happens to gold complexes under physiological conditions. The future of oncology treatment may lie in gold complexes as therapeutic agents as several gold(I) and gold(III) complexes show cytotoxicity in many cisplatin resistant cell lines.

Chapter seven, written by M. B. Cortie and A. McDonagh, covers the nanoscience of gold and gold surfaces. An overview of the field, highlighting the chemical and physical aspects of the newest research in the field, as opposed to specific technological applications is presented. Gold is ideal to work with in nanotechnology because of its chemical stability, optical properties, and its ability to conduct heat and electricity in addition to being soft and ductile. The unique affinity of gold for sulfur has also made it an ideal material for nanotechnology. Many gold nanoparticles have biological applications, including: fluorescent biological labels, the ability to detect pathogens or proteins, blood immunoassays, and DNA analyses. Colloidal gold particles can be used to target and destroy cancer cells, macrophages, and pathogens. According to the authors, "gold is immune to the corrosion of physical environments and can safely be used to target a certain area of the body at which an action is triggered." This chapter highlights several forms of gold at the nanoscale, including: clusters, nanoparticles less than 5 nm in diameter, nanospheres, nanoshells, nanorods, mesoporous sponges, thin films, and the agglomeration of nanoparticles into disordered aggregates and colloidal crystals. The application of gold films and nanoparticles in surface plasmon resonance spectroscopy, fluorescence, luminescence and heterogeneous catalysis is also covered. A detailed discussion of the surface chemistry of gold focusing on surface bonding to atoms in addition to sulfur is included.

The final chapter of the book, written by Silverio Coco and Pablo Espinet, focuses on liquid crystals based on gold compounds. The chapter opens with a detailed explanation of the basic concepts of liquid crystals. The authors cover liquid crystals with gold complexes bearing pyridine, dithiobenzoate, isocyanide, isocyanide-halide, isocyanide-alkynyl, isocyanide-fluorophenyl, and ionic bis(isocyanide) ligands. A brief discussion of gold-based liquid crystals with pyrazole ligands, which are important in forming non-rod like shaped liquid crystals, is also included. The authors conclude the chapter with a short discussion on using gold nanoparticles in liquid crystals.

This book provides a nice overview on the applications of gold complexes in medicinal chemistry and materials science, in particular with the luminescent characteristics associated with polynuclear gold complexes. However, the explosion of gold catalysis that occurred in organic chemistry over the last few decades was not covered. Mohr indicated this was due to a subsequent book published by Wiley in 2009. It is without a doubt that the field of organic chemistry has been profoundly affected by gold catalysis and this would be a nice addition to a book which discusses the most active areas of gold research.

The organization of the book for a reader who is not familiar with all of the topics covered is disjointed. There are only two chapters which cover the application of gold complexes in medicinal chemistry, one appearing in each section. The later chapter provides a basic understanding of gold chemistry which would be useful in the former. The disjointed nature of the book is also apparent with the topic of liquid crystals. In the third chapter, gold complexes which are liquid crystals are presented without the basic concepts behind liquid crystals. For those unfamiliar with these concepts, they are presented at the beginning of chapter eight. Despite these shortcomings, this book does present an excellent discussion of the impact of gold in certain disciplines of chemistry and prepares the reader for a profound impact of gold in several applications in the future.