SILVER (AG)

Zavarella, Carol
UNIVERSITY OF SOUTH FLORIDA

Silver (Ag)

Silver is a transition metal that has been thought to be known and used by people for at least 5000 years. It is a soft, white material that has a high degree of luster. Silver has no known discoverer and “can be obtained from pure deposits, from silver ores such as argentite (Ag_2S) and horn silver (AgCl), and in conjunction with deposits of ores containing lead, gold or copper”.[1] The general uses for silver include coins, ornaments, jewelry, silverware, photography and for electrical conductors.

Name and Composition

For my particular research project, we are using a silver precursor, CF3COOAg (Trifluroacetate) to generate the silver nanocubes that will be used as the substrate therefore I will include the composition of both pure silver as well as the trifluroacetate compound.

Table 1. Composition of Silver and Trifluroacetate. [1-2]

Silver (Ag)		Trifluroacetate - CF_3COOAg
Atomic #:	47	Carbon: Atomic Weight 12.0107
Atomic Mass:	107.8682 amu	Fluorine: Atomic Weight 18.9984032
Melting Point:	961.75° C	Oxygen: Atomic Weight 15.9984032
Boiling Point:	2212.0° C	Silver: Atomic Weight 107.8682
# of Protons/Electrons:	47	
# of Neutrons:	61	
Crystal Structure:	Cubic	

How Silver is made

Silver is found in nature either as a pure deposit or as an ore. The process to extract silver from its ore is different dependent upon the type of deposit of ore, i.e. lead, gold, or copper or as a silver ore. The general process to extract silver from an ore containing lead begins with heat. The “lead concentrates are first roasted and then smelted to produce a lead bullion from which impurities such as antimony, arsenic, tin, and silver must be removed. Silver is removed by the Parkes process which consists of adding zinc to the molten lead bullion. Zinc reacts rapidly and completely with gold and silver, forming very insoluble compounds that float to the top of the bullion. These are skimmed off and their zinc content recovered by vacuum retorting. The remaining lead-gold-silver residue is treated by cupellation a process in which the residue is heated to a high temperature (about 800 °C, or 1,450 °F) under strongly oxidizing conditions. The noble silver and gold remain in the elemental form, while the lead oxidizes and is removed".[3]

The cost of mining and extraction of metal from their ores varies and is often dependent upon their availability. Silver ore is rare and thus would be expensive due to its lack of availability. The cost to the environment however, is high, independent of the type of metal being mined. In addition to the scarring of the land sites, there is quite a bit of waste material that is produced by mining and extracting of any metal resulting in air, water and noise pollution. In order to mitigate both the economic and environmental costs, recycling of metals is highly recommended.[4]

Uses of silver

As stated above, the traditional uses for silver include coins, ornaments, jewelry, and silverware. It is also used on mirrors, solder, printed circuit boards and electrical contacts. With respect to photography, "[i]ts compounds are used in photographic film and dilute silver nitrate solutions and other silver compounds are used as disinfectants and microbiocides (oligodynamic effect). Silver metal is used industrially in electrical contacts and conductors, in mirrors and in catalysis of chemical reactions".[5] With respect to nanotechnology, silver nanocrystals have a "broad range of applications involving localized surface plasmon resonance, surface-enhanced Raman scattering, metal-enhanced fluorescence, sensing, imaging, catalysis, and antimicrobial technology.[6]

Description of its properties and relevance to the research

Silver is a transitional metal which is defined as metals that are ductile, malleable and conduct electricity and heat. Thus, silver has high electrical and thermal conductivity and is resistant to corrosion. The unique optical properties of silver make it the ideal substance to aid in plasmonics. Plasmonics is the term used to describe the density waves created when light hits the surface of a metal under certain conditions. It is this particular property that is part of the focus of the research project.

The research project involves creating a substrate of the silver nanocubes of 50 nm in edge length and attempting to create epitaxial growth using ruthenium particles. "In plasmonics, metal nanostructures can serve as antennas to convert light into localized electric fields or as waveguides to route light to desired locations with nanometer precision. With tight control over the nanostructures in terms of size and shape, light can be effectively manipulated and controlled with unprecedented accuracy".[7] Although silver nanocubes have these unique optical properties, it is poor at catalysis, particularly in CO2 conversion. However, ruthenium has excellent catalysis capabilities and is more efficient at activating CO2. It is this conversion and the concomitant energy input and transfer from the light absorption of the silver that is of interest in this research.

References

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