FINAL SEMESTER REPORT ON APPLICATIONS OF NOBLE CATALYSTS IN ELECTRONIC MACHINES .

BY

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UNDER GUIDANCE OF

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ON
APPLICATIONS OF NOBLE CATALYSTS ON ELECTROINIC MACHINES

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APPLICATIONS OF NOBLE CATALYSTS IN ELECTRONIC MACHINES

1.1 INTRODUCTION :

1.2 CATALYST:

A catalyst is a substance that speeds up a chemical reaction, but is not consumed by the reaction; hence a catalyst can be recovered chemically unchanged at the end of the reaction . A Chemical species that is neither a reactant nor a product, but is an intermediate between the two .

1.3 USE OF CATALYST :

For chemicals to react, their bonds must be rearranged, because the bonds in the products are different from those in the reactants. The slowest step in the bond rearrangement produces what is termed a transition state.

The formation of transition state requires energy known as activation energy .
The activation energy is considered as a barrier for a chemical reaction, a hurdle that must be crossed. If the barrier is high, few molecules have sufficient kinetic energy to collide, form a transition state, and cross the barrier.

Reactants with energy lower than activation energy$_a$ cannot pass through the transition state to react and become products. Hence a catalyst provides a different route, with lower activation energy for the reaction. Catalysts lower the energy barrier.

The different route helps the bond rearrangements needed to convert reactants to products to take place more easily, with a lower energy input.

In a given time interval, the presence of a catalyst helps a greater proportion of the reactant species to pick up sufficient energy to pass through the transition state and become products.

1.4 NOBLE METALS :

The **noble metals** are metals that are resistant to corrosion and oxidation in moist air . The list of chemically noble metals comprises of

Ruthenium(Ru), rhodium (Rh), palladium (Pd), silver (Ag), osmium (Os), iridium (Ir), platinum (Pt), and gold (Au).

More inclusive lists include one or more of mercury (Hg), rhenium (Re), and copper (Cu) as noble metals. On the other hand, titanium (Ti), niobium (Nb), and tantalum (Ta) are not included as noble metals although they are very resistant to corrosion

1.5 NOBLE CATALYSTS :

Metals that are resistant to corrosion and offer oxidation in moist air are known as noble metal catalysts. Noble metals include platinum , Osmaium , palladium , ruthenium , silver , iridium , and gold .

1.6 EFFECT OF NOBLE CATALYST ON GLOBAL MARKETS :

Global noble metal catalyst market is driven by its widespread applications. However, performance dependency on temperature and loss of activity through poising & thermal deactivation hamper the market growth. Moreover, high cost of the metal restrains the market growth. Ongoing R&D activities to reduce costs and improve the quality of catalysts are expected to provide lucrative opportunities for the market.

The global noble metal catalyst market is based on product application and geography. On the basis of product, the market is divided into reactive metal and catalytic reaction. Reactive metals segment is further bifurcated into Ag catalyst, platinum catalyst, palladium catalyst, rhodium catalysts, and others. Homogenous catalysis uses and heterogenous catalysis uses are the subdivisions of catalytic reaction. Applications covered in the study include pharmaceuticals, refinery, automobile, and others. Geographically, the market is focused across North America, Europe, Asia-Pacific, and LAMEA.

Some important names in the market are :

- BASF SE
- Evonik Industries Ag
- Johnson Matthey Plc.
- Heraeus Group
- Clariant International Ltd.
- Umicore SA
- Alfa Aesar
- Vineeth Precious Catalysts Pvt Ltd.
- Shaanxi Kai Da Chemical Engineering Co., Ltd.
- Arora Matthey

1.7 IMPORTANT FIELD APPLICTIONS OF NOBLE CATALYST :

- Pharmaceutical
- Refinery
- AUTOMOBILES
- ELECTRONIC MACHINES

1.8 USE of noble catalyst IN ELECTRONIC MACHINES :

Platinum group metals that are platinum, palladium, rhodium, iridium, ruthenium and osmium—can be found in products we use in every day life , such as catalytic converters, drugs and medical devices, and many other electronic devices .
Platinum and ruthenium are used in manufacturing of our computer and are also present in the glass of our computer screens .

The data storage capacity of our computers are due to platinum . Since each hard drive contains more than one platter or disk where data is stored using the magnetic surfaces.

The strength of the magnetic field generated by the surface layer identifies how much data can be recorded on a given surface. Addition of platinum to the cobalt magnetic alloy enhances the magnetic properties of the surface and therefore its storage capacity.

According to INTERNATIONAL PLATINUM GROUP METALS ASSOSCIATION
palladium is used for multi-layer ceramic (chip) capacitors (MLCC). MLCCs store energy in electronic devices for broadcasting equipment, mobile telephones, computers, electronic lighting and high voltage circuits.

Smaller amounts of palladium are used in conductive tracks in hybrid integrated circuits and for plating connectors and lead frames .

- Latinum, palladium, rhodium and iridium are used to coat electrodes which help to control the flow of electricity.

- Palladium is used in most microprocessors and printed circuit boards.

- Platinum is used to make fiberglass, liquid-crystal display (LCD) glass and flat-panel displays, and cathode ray tubes.

Since these naturally-occurring metals are extremely rare therefore recycling these metals for electronic products are increasingly important source of these strategic metals. According to the GEOLOGICAL SURVEY an estimated 155,000 kilograms of these metals was recovered globally from new and old scrap including about 56,000 kilograms of such metals in North America .

2.1 MATERIALS AND METHODS

A noble .catalyst comprises an alloy of a noble metal and vanadium. The catalyst is particularly useful in an electrochemical cell cathode electrode. The method for making the alloy involves reacting a vanadium compound with sodium dithionite to form a sol of a finely dispersed vanadium sulfite complex, and then reacting noble metal particles with the complex in a reducing environment.

2.2 MAKING OF NOBLE METAL CATALYSTS FOR FUEL CELL ELECTRODES :

Fuel cell converts the energy of a chemical reaction between a fuel and oxidant directly into low voltage, direct current
electricity .

Problem in making an efficient fuel cell is related to chemical kinetics that is heat lost during the reaction between the fuel and the oxidant must be minimum .

Fuel cell comprises of a fuel electrode or anode, an oxidant electrode or cathode, an electrolyte positioned between the electrodes and means to introduce fuel and oxidant to their respective electrodes.

To obtain fuel cells which are practical on a commercial scale, a great deal of research has been carried out such as noble metal, can be enhanced by supporting it in the form of finely divided particles, upon either metallic or carbonaceous base materials of high surface area. The approach has proved especially useful in fuel cell applications utilizing acid electrolytes.

2.3 METHOD OF MAKING AN ALLOY OF NOBLE METAL AND VANADIUM .

STEPS OF REACTIONS ARE :

Reacting an aqueous solution of a vanadium compound with sodium dithionite to form a sol of a finely dispersed vanadium sulfite complex; and reacting finely divided unalloyed noble metal particles with said complex by intimately contacting the noble metal particles with the complex and heating to a sufficiently high temperature in at least a locally reducing environment to thermocatalytically reduce said complex and at the same time form a finely divided alloy of the noble metal and vanadium.

1. REACTION of vanadium compound with sodium dithionite is done in the presence of H_2 O_2.
2. According to step 1 noble metal is platinum.
3. Finely divided noble metal particles are supported and the resulting alloy is supported.
4. The method according to claim 4 wherein said noble metal is platinum.
5. The method according to claim 5 wherein said platinum is supported on carbon.
6. The method according to claim 1 suggests step of heating includes heating to at least 600° C. to effect the reaction.
7. The temperature is 800°-1000° C.
8. The contact between the noble metal particles and the vanadium sulfite complex particles is achieved by dispersing said finely divided particles of noble metal in the sol of the said vanadium sulfite complex and then removing the liquids.
9. The contact between the supported noble metal particles and the vanadium complex is achieved by dispersing the noble metal covered support material in the sol of the vanadium complex and

letting the said vanadium complex absorb on the support material and then drying the solids to produce an intimate mixture of noble metal particles and vanadium complex particles on the support material.

10. Reaction of an aqueous solution of a vanadium compound with sodium dithionite includes reacting in the presence of H_2 O_2.

11. The methods suggests heating to at least 600° C to effect the reaction.

12. The temperature is 800°-1000° C.

13. The aqueous solution of vanadium compound is V_2 O_5 in NaOH.

14. Alloy of platinum-vanadium has a surface area of at least 30 m^2 /g of platinum in the alloy.

15. It involves catalytically reducing oxygen, the step of catalytically reducing oxygen using a catalyst comprising a noble metal-vanadium alloy, said alloy having a catalytic activity for the reduction of oxygen greater than the catalytic activity of the noble metal in unalloyed form.

16. The surface area of the alloy is at least 30 m^2 /g of noble metal in the alloy.

17. According to the process the alloy is supported.

18. The surface area of the alloy is at least 50 m^2 /g of noble metal in the alloy.

19. The noble metal is platinum.

20. The alloy is supported on carbon.

21. An electrochemical cell comprising a cathode electrode, said electrode including a catalyst comprising a noble metal-vanadium alloy, said alloy having a catalytic activity for the reduction of oxygen greater than the catalytic activity of the noble metal in unalloyed form, said cell including phosphoric acid electrolyte.

22. The noble metal is platinum and the surface area of the alloy is at least 30 m^2 /g of platinum in the alloy.

23. The alloy is disposed on conductive support particles.

24. The surface area of said supported alloy is at least 30 m^2 /g of noble metal in the alloy.

25. The noble metal is platinum and the support particles are carbon.

26. The cell according to claim 26 wherein the surface area of the alloy is at least 50 m^2 /g of platinum in the alloy.

27. An acid fuel cell including phosphoric acid electrolyte and a cathode electrode, said electrode comprising an electrically conductive substrate and a layer of catalyst disposed on said substrate, said catalyst comprising a platinum-vanadium alloy supported on carbon particles, said alloy having a catalytic activity for the reduction of oxygen greater than the catalytic activity of supported platinum in unalloyed form, and a surface area of at least 30 m^2 /g of platinum in the alloy.

Two most common application fileds are

1. U.S. Ser. No. 922,004.

2. U.S. Pat. No. 4,186,110

For making Cermet resistor using the elements utilizing silver-gold alloy to improve the contact resistance variations and the method of making the element .

IT basically relates to thick film electrical resistors of the cermet type and in particular to a cermet resistor with an improved contact resistance variation, and the method of producing such resistors.

METHOD OF MAKING :

A film type material having generally spherical globular particles of a gold-silver alloy is embedded in the surface comprising the steps of :

Mixing of a gold and silver resinate in the preparation of the desired alloy to a mixture of glass powder and noble metal resinates , heating the mixture to drive off the organic materials in the resinates and to allow the gold and silver to form an alloy, cooling the resultant material, grinding the resultant material to powder, mixing the powder with a volatile compound to form a paste and applying the paste to an electrically nonconductive surface in the configuration desired, heating the paste to a temperature sufficient to drive off the volatile

compound and melt the glass, holding the material in the moltan state for a time sufficient to allow the gold-silver alloy to rise to the surface, and cooling the material to solidify the glass with the gold-silver alloy embedded in the surface.

TWO important application of cermet resistors :

1. U.S. Pat. No. RE 27,603
2. U.S. Pat. Nos. 2,950,996

3.1 RESULTS AND DISCUSSIONS :

Noble metals comprise any of several metallic chemical elements that are outstandingly resistant to corrosion and oxidation, even at elevated temperatures. This group is not strictly defined, but the tentative list includes ruthenium, rhodium, palladium, silver, osmium, iridium, platinum and gold, in order of atomic number. The emerging properties of noble metals are attracting huge interest from the translational scientific community and have led to an unprecedented expansion of research and exploration of applications in numerous fields . Noble metal nanomaterials can be synthesised both by top-down and bottom up approaches, as well as via organism-assisted routes, and subsequently modified appropriately for the field of use. Nanoscale analogues of gold, silver, platinum, and palladium in particular, have gained primary importance owing to their excellent intrinsic properties and diversity of applications; they offer unique functional attributes, which are quite unlike the bulk material. Modulation of noble metal nanoparticles in terms of size, shape and surface functionalisation has endowed them with unusual capabilities and manipulation at the chemical level, which can lead to changes in their electrical, chemical, optical, spectral and other intrinsic properties. Such flexibility in multi-functionalisation delivers ‘Ockham's razor’ to applied biomedical science. In this feature article, we highlight recent advances in the adaptation of noble metal nanomaterials and their biomedical applications in therapeutics, diagnostics and sensing.

3.2 ACCEPTANCE IN GLOBAL MARKET :

A precious metal is a rare, naturally occurring metallic chemical element of high economic value. Chemically, the precious metals tend to be less reactive than most elements (see noble metal). They are usually ductile and have a high lustre. Historically, precious metals were important as currency but are now regarded mainly as investment and industrial commodities. Gold, silver, platinum, and palladium each have an ISO 4217 currency code.

Among the product type, silver is projected to account a significant share of the global market. The key factors that attribute to the major share is due to increasing demand and wide range in applications such as jewellery industries, bioscience and electrical machines etc .

REGIONS HAVING LARGE SHARES OF NOBLE METALS :

1.North America

2.Europe

3.China

4.Japan

3.3 ADVANTAGES OF NOBLE CATALYSTS :

BECAUSE of their unique properties, precious metals have become an integral part of daily life. Their resistance to corrosion and good malleability make them useful not only for jewellery, but also for a wide variety of other industries and products.

Whether as sensors in the steel industry, catalysts for satellite thrusters or chemical processes, contact materials in the electronics and automotive industries, or in glass coatings, most industrial products contain precious metals from Heraeus.

Some important fields of use :

1. GOLD

   JEWELRY

   BARS/COINS

   DENTAL ALLOYS

   BONDING WIRES

2. SILVER

   CONDUCTIVE

   PASTES

   ELECTRICAL CONTACTS

   CATALYSTS

3. PLATINUM

   CATALYSTS

   SENSORS

   GAUGES

4. PALLADIUM

   CATALYSTS

   BARS/COINS

5. IRIDIUM

   SPARK PLUGS

   CATALYSTS

   CONDUCTORS

   SEMICONDUCTORS

6. RHODIUM

   CATALYSTS

   ALLOYS

7. RUTHENIUM

   ANODE COATING

   CATALYSTS

3.4 DISADVANTAGES

3.4.1 Cost

Like virtually any investment you buy, gold and silver purchases entail a commission. And those commissions are usually higher than you would pay to buy a stock or bond (though they are generally lower than real estate costs).

Premiums fluctuate according to market conditions, and also by dealer, but generally speaking…

- Coins are more expensive than bars, since they have more intricate designs.
- Silver is more expensive than gold, since it costs just as much to manufacture as gold but the product sells for much less.
- Online dealers are usually less expensive than your local coin shop, even with shipping fees, and may have a greater selection. Many online dealers waive shipping and insurance charges (usually billed as one fee) with a minimum purchase.

Premiums on a rare coin or a numismatic product are considerably higher, since these are collectibles.
Overall, while it costs more to buy bullion than other investments, premiums are not excessive. Industry margins are low, so premiums are not likely to come down much further .

3.4.2 Storage

When you buy physical metal, you'll need to store it somewhere. You don't have to worry about "storage" with a stock or bond (unless you decide to take delivery of certificates). Bullion storage entails a fee if you pay someone else to store it for you, or risk of theft or loss if you store it at home.

Using a storage facility or a safe deposit box at a bank entails on ongoing fee. However, if you buy a bullion-backed ETF, you also pay on ongoing commission, which is used in part to pay for storage. You don't get a bill like you do from your bank or storage facility, but you're charged just the same. That fee is usually not onerous; GLD, the largest bullion ETF, currently charges 0.40% annually.

But it's not just the fee you have to consider. The security of the metal and the safety of you and your loved ones should be part of the decision process, too. If you keep all your bullion in the house, you could lose it in a robbery… or fire… or natural disaster. A home safe is not fullproof, either; they only buy you time, since most can be broken into sooner or later, or a thief could demand you open it – while holding a knife to your sweetie's head, like happened to a friend of my father.

A safe deposit box at the bank gets it out of the house, but it introduces other problems. First, contents of bank boxes are not insured; FDIC insurance only covers bank deposits, not box deposits. Second, if you need your bullion in a hurry but the bank is closed for the weekend or a holiday or some sort of banking emergency (several banks were closed during 9/11, for example), you're out of luck. Last, one of the advantages of owning physical metal is that it's outside of the banking system – but using a bank box leaves it exposed to that system.

Keeping some bullion close at hand is wise. One of its greatest strengths is that it can be used in an emergency. So having immediate access to at least some of your stash gives you that ability if you ever need it.

But for ultimate safety and security, nothing beats private, professional storage. It's outside the banking system, and gets it out of the house. And there are some very reputable programs now that are very cost-effective .

3.4.3 Liquidity

If you hold physical metal, it might not be immediately liquid. While some states have passed laws making gold and silver legal tender, you still can't buy groceries or a new car with gold coins or silver bars. You first have to convert to currency (unless you use them for barter, which could be feasible in some circumstances).
There's one way around this liquidity drawback: online storage. With an online storage account, you can sell your gold or silver at any time (during trading hours), just like a stock. This gives you instant liquidity, as funds are dispersed after settlement, usually within 1-2 business days, also just like a stock.

Bullion ETFs have instant liquidity too, though they have their own set of risks

3.4.5 Taxes

Believe it or not, gold and silver bullion are recognized by the IRS as "collectibles." This means you pay a maximum 28% capital gains tax if the metal is held for over one year. Taxes on long-term capital gains such as stocks, on the other hand, are lower for most investors (the highest rate is currently 20%).

3.4.6. Don't Produce Income or Interest

Last, one of the knocks on owning any form of gold or silver is that they don't pay interest or dividends. Stocks and bonds, on the other hand, can easily do this. Real estate can provide rental income.

But this argument is erroneous. Gold's purpose is not to produce income; its function is as money and a store of value.

The dollar bills in your wallet don't produce income, either – until you buy an interest-bearing bond or dividend-paying stock. Gold is not a currency at this time in history, but its biggest use historically is as money, including today.

4.1 CONCLUSION:

Noble catalysts are increasingly becoming a great asset for the global market . Due to their impressive abilities of surviving in the harsh conditions .
Their properties are of great importance for the industries such as pharmaceutical , ornamental , refinery and many other .

According to my report I have tried reflect the viable fields of usage of noble catalysts in the machines.

Due to the above mentioned limitations these catalysts are not that accepted at the ground level of working . BUT Noble catalysts though due to their rareness and high level of cost are being accepted in the global market at the professional level as they provide great level of assistance in unnatural conditions .

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