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REVIEW ARTICLE

FUTURE PROSPECTIVES OF NANO ONIONS: A REVIEW

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ABSTRACT

Carbon onions represent one of the least studied carbon nano-materials, and are seeing a large increase in attention for energy storage applications. Because of their unique 0-D structure, small (<10 nm) diameter, high electrical conductivity, and relatively easy dispersion, compared to 1-D nano onions and 2-D graphene, OLC has been shown to be ideal as a conductive additive to battery and super-capacitor electrodes, or as active material for super-capacitor electrodes for high-power applications and for low temperature devices using ionic liquid electrolytes. This review reveals many spectacular benefits of carbon nano onions during their recent applications in different areas of pharmacy and medicine. The discovery of this bio nanotechnology has opened new alternatives more effective than the ancient drug delivery methods since CNOs can pass through cell membranes, carrying drugs, genes, bio-molecules, vaccines, and so forth deep into the target cells or organs previously unreachable. Another novel approach is the use of collagen CNOs materials as scaffolds in tissue generation and artificial implants because CNOs resist biodegradation and are a powerful engineering candidate over other existing materials used to repair defective organs. Besides, CNOs combined with biosensors or other materials have proven excellent implements for the therapeutic monitoring and the diagnosis of diseases as well as for the analysis of drugs in different areas. Overall, this nanotechnology could revolutionize the therapeutic concepts in the future and give a glimmer of hope for the treatment of many incurable diseases. However, despite many of the surprising results of CNOs obtained during the beginning of this research field, there are still tremendous opportunities to be explored and significant challenges and risks to be solved.

INTRODUCTION

A fullerence is a molecule of carbon in the form of a hollow sphere, ellipsoid, tube, and many other shape. Buckminster fullerene is one type of fullerene. Its molecules have 60 carbon atoms arranged in a hollow sphere. Cylindrical ones are called carbon nano tubes. Carbon nano onions are the spherical carbon particles. **[1]** Carbon nano-onions are quasi-spherical carbon nano particles. These are spherical particles based on multiple carbon layers surrounding buckyball core.

They have been observed to either encapsulate metals or to consist only of carbon layers. Carbon onions consist of spherical closed carbon shells and owe their name similar to the concentric layered structure resembling that of an onion. Carbon onions are sometimes called carbon nano-onions (CNOs) or onion-like carbon (OLC). These names cover all kinds of concentric shells, from nested fullerenes to small (<100 nm) polyhedral nanostructures. This review is dedicated to these matters. Currently scientists are working with great hopes on synthesizing new materials encapsulated in nano-carbon onions for medical diagnostics.

The electrochemical applications of carbon onions are reviewed with an emphasis on supercapacitor electrodes. Carbon nano-onions (CNOs), which consist of concentric graphitic shells, represent another new allotropic nano-phase of carbon materials.

CNOs have already been shown to offer a variety of potential applications such as solid lubrication, electromagnetic shielding, fuel cells, heterogeneous catalysis, gas and energy storage, and electro-optical devices owing to their outstanding chemical and physical properties. According to a recent study, CNOs can also be used to produce ultra high power micrometer-sized super-capacitors due to their accessible external surface area for ion adsorption. **[2]**

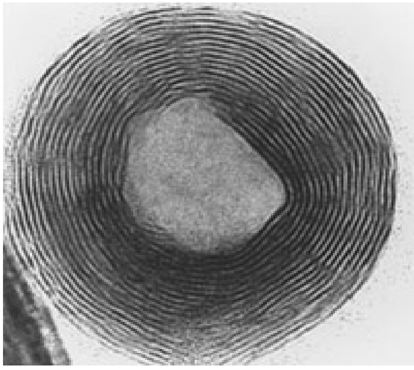

Fig 1 Carbon Nano onions of 5nm **[3]**

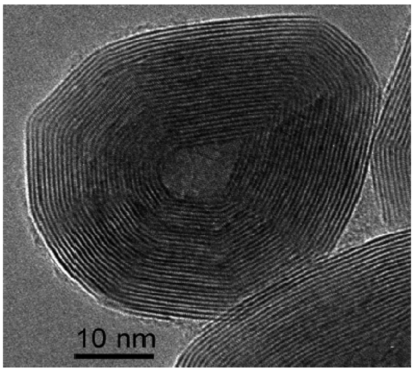

Fig 2 Carbon Nano onions of 10nm **[4]**

Historical Background

1. Sumio Iijima discovered OLC (onion like carbon) in 1980 while looking at a sample of carbon black in a transmission electron microscope.OLC was not produced in bulk, but rather was observed as a by-product of carbon black synthesis.
2. About a decade later in 1992, Daniel Ugarte put forth a formation mechanism for the spherical graphitic structure. By focusing an electron beam on a sample of amorphous carbon, he was able to observe the formation of OLC *in situ*. Under an electron beam, the amorphous carbon graphitizes and begins to curl, and after sufficient time, the graphitic carbon closes on itself, forming an onion. It was discovered that the curving and closure occurs in order to minimize the surface energy of the newly formed edge.
3. Kuznetsov et al. obtained CNOs by high-temperature annealing of diamond nano particles under vacuum.
4. Cabioc'h et al. prepared CNOs by high-dose carbon onion implantation into copper and silver.
5. Sano et al. Fabricated CNOs by arc discharge between two graphite rods immersed in water.
6. Recently, Hou et al. reported the high-yield synthesis of CNOs in counter flow diffusion flames. CNOs can only be produced in minute quantities by lots of methods such as electron beam irradiation of carbon materials. **[5]**

Structure of Carbon Onions

The onions consist of graphene shells with pentagonal and other defects required to have closed-shell structures. Structural properties of OLC vary significantly depending on the synthesis conditions. Focusing on OLC derived from the annealing of nano diamond between 1300 and 1800 °C, the BET specific surface area (SSA) from N_2 gas adsorption varies between 400 and 600 m^2/g (Fig. 3a). There is no accessible internal porosity for OLC, so the SSA is dependent on the density of the material and the surface of the particles. At lower annealing temperatures, there is residual diamond in the sample causing a lower SSA due to a higher density of nanodiamond compared to graphitic carbon forming onion shells. A maximum at 1500 °C is found after all diamond is transformed to OLC and the particle has a rough (defective) surface, and the subsequent decrease in SSA is due to sintering and formation of larger polygonized particles as annealing temperature in increased. The pore size distribution of OLC is broad in the mesoporous range, as any "pore" is actually formed by the space between multiple onions, and does not vary significantly between synthesis conditions. Conversion from nano diamond to a fully graphitized onions was investigated using X-ray diffraction (XRD) (Fig. 3b). The nano diamond precursor shows pronounced diamond peaks, as expected, in addition to a small peak for (002) graphite. Upon annealing for 30 minutes at 1400 °C, three peaks appear for graphite that are relatively broad and weak in intensity, probably because the graphitic carbon is still defective and incomplete shells are formed. The graphitic carbon peaks grow for the sample annealed at 1700 °C, with some residual diamond peaks. Finally, after annealing at 2000 °C for 30 minutes, no diamond peaks are present, with very pronounced peaks for graphite **[6].**

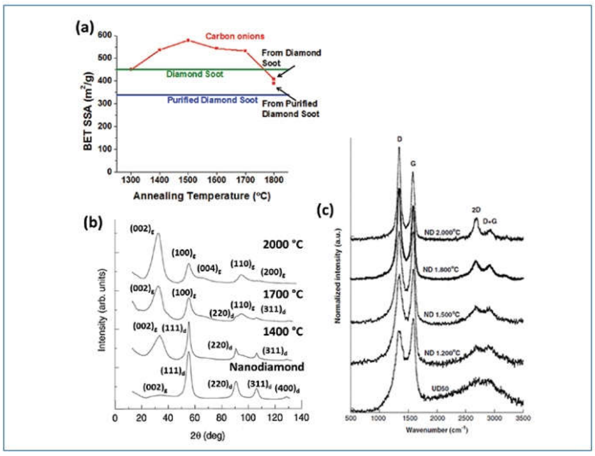

Fig 3 a) BET specific surface area of raw diamond soot and annealed nano diamond (carbon onions) (b) XRD patterns of annealed nano diamond and (c) Raman spectra of annealed nano diamond **[7]**.

Raman spectroscopy was used by Portet, *et al.* to study the surface structure of carbon onions as they are annealed from nano diamond at temperatures between 1200 and 2000 °C (Fig. 3c). The nano diamond precursor (UD50 grade1) used was a detonation nano diamond soot, that is comprised of disordered carbon, carbon onions, and diamond nano particles, with ~25 wt% of sp^3 carbon and ~75 wt% of sp^2 carbon. The Raman spectra for all samples contain two peaks at 1350 and 1600 cm^{-1}, corresponding to the D-band for disordered carbon and the G-band for graphitic carbon, respectively, in addition to second order peaks for the 2D band at ~2700 cm^{-1} and for the G+D band at ~2850 cm^{-1}. The spectrum for UD50 shows two very broad D and G peaks, and the 2D and D+G peaks are un-resolvable, implying a highly disordered graphitic carbon present in the detonation soot. Annealing the nano diamond at 1200 °C causes a narrowing of all peaks, and appearance of the resonant peaks. As the samples are annealed at higher temperatures, up to 2000 °C, the peaks continue to narrow as the sp3 carbon and disordered carbon is further graphitized.

The ratio of the D to G band (*I*D/*I*G, not shown) decreases significantly upon annealing due to the increase in ordering of the carbon particles. **[8]**

Different Manufacturing Techniques of Carbon Nano Onions

1. Although OLC has been synthesized by many different methods in the last 30 years, large scale production (gram quantities) of OLC was first realized in 1994 by Vladimir Kuznetsov and co-workers, who used vacuum annealing of a nano diamond precursor.
2. Similar to vacuum annealing, other groups have also utilized annealing in inert gases to transform nano diamond, which is currently produced in ton quantities, to OLC **[1]**. This is one of the methods that has a potential for industrial applications, as the onion yield is close to 100% and the manufacturing volume is only limited by the size of the furnace, and can be scaled accordingly. This material rarely has ideal spherical carbon onions, but can be produced in large quantities and finds practical applications. The transition of nano diamond to a carbon onion can be seen in a molecular dynamics (MD) simulation ((Fig. 4a-c). A 2-nm particle of nano diamond (Fig. 4a) was annealed at 1400 °C (Fig. 4b) causing the outer layers of the nano diamond to convert to graphitic carbon; however the annealing was not at high enough temperature to convert the entire particle. At higher temperatures (Fig. 4c) the entire particle is converted to an OLC particle . At the highest annealing temperatures, the OLC particle begins to polygonize (Fig. 4d) as the structure becomes more ordered. The particle size of OLC produced via nano-diamond annealing is dependent on the nano diamond precursor, which is generally about 5nm in diameter, producing onions in the 5-10 nm size range .**[9]**
3. Arc discharge between two graphite electrodes in water represents another synthesis technique, generating OLC of slightly different structure than from annealing of nano diamond. A dc current of 30A and 17 V was applied between two graphite electrodes in water causing the carbon to evaporate at the location of the arc due to the extreme heat generated. The carbon vapour rapidly condenses into highly spherical OLC particles (Fig. 4e) and will float on the water surface, waiting to be collected for analysis. Consumption of the anode was about 100 mg/min, with the carbon products being produced at 20 mg/min. Synthesis by arc discharge can be performed at ambient pressure and temperature, avoiding the use of expensive equipment or catalysts, however the yield is low and samples contain nano tubes and amorphous carbon formed along with carbon onions **[10]**.
4. Hollow carbon onions have been produced with the aid of metal nano particles. First, the metal and carbon were evaporated by an arc discharge method, similar to the one described earlier. The resulting product is a metal particle encapsulated by layers of graphitic carbon. When the system is exposed to the beam of a transmission electron microscope (TEM), the metal particle migrates a few atoms at a time through the carbon layers, which can be seen *in situ*, and leaves a hollow OLC particle (Fig 4f). Laser excitation of ethylene causes the gas to decompose and produces solid carbon at high temperatures. in water,9 and (f) electron beam irradiation.**[11]**
5. The process, used by Gao, *et al.*, is performed in air and uses a high-energy laser to convert the hydrocarbon to a solid carbon onion. This has potential to be used for large-scale production, as it can be scaled up, as it is showing a synthesis rate of 2.1 g/hour. This, along with annealing of detonation nano diamond, is another feasible synthesis method for industry.
6. Well graphitized carbon nano-onions (CNOs) with large yield have been synthesized by the catalytic decomposition of methane over an unsupported Ni–Fe catalyst at 850 C. The unsupported Ni–Fe catalyst was prepared by a reduction-substitution method. In the Ni–Fe alloy particle, Fe(Ni) phase (kamacite) transforms to Fe–Ni phase at the high temperature for hydrogen reduction and chemical vapour deposition. The synthesized CNOs contain either a Fe & Ni particle or a hollow core with thick graphitic layers and a polyhedral shape. Based on the characterization. A growth mechanism for the CNOs is proposed. Then the growth of CNOs was conducted at 750˚ C, 850˚ C and 950˚ C for 1 h by introducing the mixture of CH_4.**[12]**

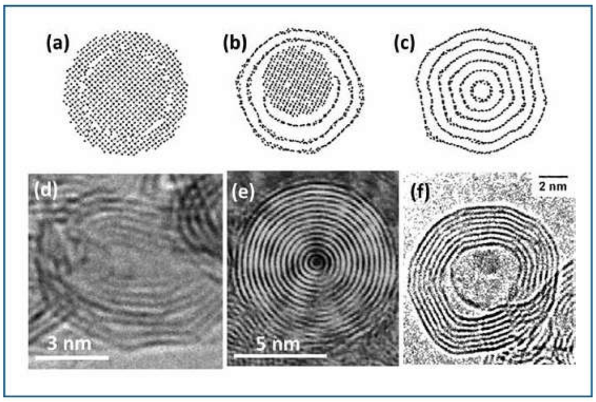

Fig 4 Molecular dynamics simulation of (a) pristine nano diamond, (b) nano diamond annealed at 1400 °C, (c) nano diamond annealed at 2000 °C, and carbon onions synthesized via (d) annealing of nano diamond at 2000 °C (e) arc discharge between two carbon electrodes

Advantages of Nano-onions

1. Nano onions can actually revolutionize a lot of electronic products, procedures, and applications. The areas that benefit from the continued development of nanotechnology when it comes to electronic products include nano transistors, nano capacitors, super-capacitors, quantum computers and many more.
2. Nano onions also benefit the energy sector. The development of more effective energy-producing, energy-absorbing, and energy storage products in smaller and more efficient devices is possible with this technology. Such items like batteries, fuel cells, and can be built smaller but can be made to be more effective with this technology.
3. The materials produced from nano-onions are often stronger, more durable, and lighter than those that are not produced with the help of nanotechnology.
4. In the medical world, nano onions serves as a boon since these can help in creating smart drugs. These help cure people faster and without the side effects that other traditional drugs.

Disadvantages of Nano Onions

1. Included in the list of disadvantages of this science and its development is the possible loss of jobs in the traditional farming and manufacturing industry.
2. It brought about the crash of certain markets due to the lowering of the energy sources due to the possibility of developing alternative sources of energy that are more efficient and won't require the use of fossil fuels.
3. Since these particles are very small, problems can actually arise from the inhalation of these minute particles, much like the problems a person gets from inhaling minute asbestos particles.
4. Presently, nanotechnology is very expensive and developing it can cost you a lot of money. It is also pretty difficult to manufacture, which is probably why products made with nanotechnology

Applications of Carbon Nano Onions

Biological sensing: CNOs were covalently functionalized with bio-molecules and were studied as biosensors by using avitin–biotin interactions. The CNO served as linking layers between the bio-molecules and the surface of the sensor and led to an amplified signal of the biosensor as determined by surface plasma on resonance spectroscopy. In addition, the biocompatibility of CNOs was investigated and found to be excellent.

Environmental remediation: An application of CNOs in environmental remediation was revealed that surface-oxidized CNO in aqueous suspensions have a high sorption capacity for heavy metal ions such as Pb^{2+}, Cu^{2+}, Cd^{2+}, Ni^{2+} and Zn^{2+}. The sorption capacity of oxidized CNOs was found to be up to ten times higher than the one of fullerene C_{60} .These encouraging results could be a first step toward in situ remediation of heavy metal contaminants. **[13]**

Lithium-Ion batteries: Carbon nano onions are widely studied for a use in lithium ion batteries. However, also CNOs were studied for a potential application as anode materials. Han et al., for example, reported the large scale synthesis of CNOs starting from $CuCl_2{\cdot}2\ H_2O$ and CaC_2 and found that they exhibit a high capacity in combination with a promising cycling performance, which renders these as-prepared CNOs as potential node materials for lithium-ion batteries.

Capacitors: Carbon materials are commonly used as electrode materials in capacitors. The electrochemical performance of CNO electrodes was compared with electrodes made with nanodiamonds, multi-wall carbon nano tubes and carbon black. Following this initial work, several groups studied CNO materials in super capacitor electrodes. Bushueva et al. for example, found capacitance values of the investigated CNO material of 20–40 F·g ^{1} and 70–100 F·g ^{1} with acidic or basic electrolyte solutions, respectively. In 2010, Pech et al. published the preparation and characterization of ultrahigh-power micrometer-sized super capacitors based on CNOs. Another strategy to increase the CNO capacitance is the activation of the CNO surface by treatment with 6 M KOH, creating porosity in the outer shells of the CNOs. The activated CNOs show largely improved properties compared to pristine CNOs with a maximum specific capacitance.

Fig 5 Activation of Carbon Nano Onions **[14]**

Fuel cells: CNOs were also investigated as catalyst support for application in direct methanol fuel cells. For this, Xu et al. prepared CNOs decorated with Pt nano particles (Pt-CNO) and compared the performance of this novel catalyst material with common Pt/Vulcan XC-72 with encouraging results. The novel Pt-CNO catalyst showed a higher surface area and smaller Pt particle size (3.05 nm vs 4.10 nm) than the reference system and the catalytic activity for the electro oxidation of methanol was increased by about 20%, rendering CNOs as a promising catalyst support for fuel cells.

Catalysis: One of the most important catalytical reactions in industry is the oxidative dehydrogenation (ODH) of ethyl benzene to styrene. In 2002, Keller et al. published a study showing the potential of carbon nano onions as a catalyst for this reaction with conversion levels of up to 92% .

Tribology: In tribology, CNOs are widely studied and have shown promising results as lubricants. In 2002, Cabioc'h et al. Reported that CNOs incorporated in silver layers significantly reduced wear, while the friction coefficient is largely unaffected by their presence. The lubrication of CNOs between two surfaces is caused by rolling–sliding of the CNO nano particles. **[15]**

Optical limiting: CNOs were also studied in optics and found to exhibit very efficient optical limiting [23]. The optical response of CNOs is stronger than that of nano diamonds. In addition, the nonlinear optical refraction of the CNOs was found to be negligible. Finally, transient absorption studies of covalently functionalized CNOs yielded evidence for a strong difference of the absorption coefficients in the ground and excited state, which gives further rise to a possible application of this CNO material in optical limiting.

Terahertz-shielding: In recent years, terahertz devices, circuits and terahertz based communication systems have become important in many fields. This makes the development of materials for terahertz shielding essential, to limit electromagnetic interferences and thus reduce for example noise in cables and communication systems and signal coupling Carbon materials presence. Further studies investigated the use of CNOs as a solid state lubricant, where the aim was to improve the lubricating lifetime for space applications.

Anti- Cancer Therapy: These nano particles have a hydrophobic core that can carry the anticancer drug and water soluble exterior that can solublize it. This delivery system of anticancer drugs avoid the need of non aqueous agents example: Poly-oxyethylated castor oil used to solubilize paclitaxel (anti-cancer drug). These non aqueous solvents cause allergic reactions and side effects at site of infection. The cytotoxic levels of the nano particle drugs are effective in anti cancer therapy. Carbon nano particles used as carriers can be effectively applied in antitumor immunotherapy. This therapy consists of stimulating the patient's immune system to attack the malignant tumor cells. This stimulation can be achieved by the administration of a cancer vaccine or a therapeutic antibody as drug. The hyperthermia therapy using carbon nano onions has been recently developed as an efficient strategy for the cancer treatments. The photo thermal effect can induce the local thermal abolition of tumour cells by excessive heating of nano particles**. [16]**

Infection Therapy: The resistance of infectious agents against numerous antiviral, antibacterial drugs or due to certain vaccine inefficacy in the body, the nano onions have been assayed to resolve these problems. Functionalized carbon nano onions have been demonstrated to be able to act as carriers for antimicrobial agents such as the antifungal amphotericin B. Carbon nano onions can attach covalently to amphotericin B and transport it into mammalian cells. This conjugate has reduced the antifungal toxicity about 40% as compared to the free drug.

Neuro-degenerative Diseases: As a promising biomedical material, carbon nano particles have been used in neurosciences because of their tiny dimensions and accessible external modifications, they are able to cross the blood-brain barrier by various targeting mechanisms for acting as effective delivery carriers for the target brain. They have been used to deliver acetylcholine in the treatment of Alzheimer's disease with high safety range. **[13]**

Marketed Formulations available for CNO's:

S	API Name	Pharmaceutical use	Dosage form	Mfg.Company
1.	Rapamycin	Immunosupressent	Coated Tablet	Taj-Pharma LTD.
2.	Aprepitant	Anti-emetic	Hard Capsule	Merck Pharma
3.	Fenofibrate	Hypercholesterolemia	Tablet	LUPIN.LTD
4.	Megestrol	Anti-anoretic	Suspension	Par Pharmaceuticals
5.	Paclitaxel	Anti inflammatory	Injection	Intaj Labortaries PVT. LTD.
6.	Thymectacin	Anti-cancer	Intravenos Injection	Cel-Med Pharmaceuticals
7.	Morphine Sulphate	Phycho Stimulant	Extended Release Capsule	King Pharmaceuticals
8.	Methyl Phenidate	CNS stimulant	Sustained Release Tablet	Novartis
9.	Tizanidine HCL	Muscle Relaxant	Hard Capsule	Acorda Pharmaceuticals
10.	Amphotericin	Fungal Infection	Intravenous Injection	Enzon
11.	Estradiol	Monopausal Therapy	Cream	Novavax

Objective of the Work

The main objective of the review work is given as follows:

1. To gain all the background information about the carbon nano onions and its various
2. sizes and shapes.
3. To acquire the information regarding carbon nano onions, the characterstics, advantages, disadvantages and possible reasons for preparation.
4. To correlate between carbon nano onions and other nano-technological products. If there any possible.
5. To gain knowledge regarding MOA of chemical entities of carbon nano onions on various diseases.
6. To know about the newer techniques and advancements in the field of drug delivery system for various diseases by using carbon nano onions as a drug of choice.
7. To know the pros and cons of the carbon nano onions used in the treatment.
8. Feasibility of Carbon nano onions in targeted drug delivery systems.
9. The Newest dosage forms under pipeline related to carbon nano onions.
10. The study and the work achieved so far regarding it i.e. prior art to CNO.
11. The unsolved issues in use, storage and manufacturing of CNO.

REVIEW OF LITERATURE

Chenguang Zhang *et al.* reported that well graphitized carbon nano-onions (CNOs) with large yield have been synthesized by the catalytic decomposition of methane over an unsupported Ni–Fe catalyst at 850 ˚C. The unsupported Ni–Fe catalyst was prepared by a reduction-substitution method. The synthesized CNOs contain either a $Fe_{0.64}Ni_{0.36}$ particle or a hollow core with thick graphitic layers and a polyhedral shape. Based on the characterization the catalyst involved in the synthesis of carbon products is Fe–Ni–C austenite rather than the $Fe_{0.64}Ni_{0.36}$. A growth mechanism for the CNOs was proposed. **[17]**

A**lbert G. Nasibulin** found that new catalyst precursors (copper and nickel acetyl acetonates) have been used successfully for the synthesis of and onion particles from carbon monoxide. Catalyst nanoparticles and carbon products were produced by metal–organic precursor vapour decomposition and catalytic disproportionate of carbon monoxide in a laminar flow reactor. Hollow carbon onion particles (COPs) were produced in the presence of copper particles at 1216 ˚C. The COPs were from 5 to 30 nm in diameter and consisted of several concentric carbon layers surrounding a hollow core. The mechanisms for the formation of COPs were discussed on the basis of the experimental. **[18]**

Yang Gao and Paul Goodman concluded that carbon nano-onion (CNO) is a promising candidate for high-power super capacitors due to the nonporous outer shell, which is easily accessible to electrolyte ions. However, the nonporous ion-accessible outer shells also limit the energy density of the CNOs, which requires large specific surface area. Introducing porosity to the outer shells of CNOs can effectively improve the specific surface area by exposing the inner shells to electrolytes. In this study, the electrochemical performance of super capacitor electrodes based on CNOs was improved through the controlled introduction of porosity on the outer shells of CNOs by chemical activation. The capacitance of the activated CNOs was found to be five times larger than the pristine ones with a measured power density of 153 kw/kg.**[19]**

Hua He et al. reported that Carbon nano-onions are allotropes of carbon, made of graphite and constructed in spherical shape with nanometer in diameter. Their impressive structural, mechanical, and electronic properties are due to their small size and mass, their strong mechanical potency, and their high electrical and thermal conductivity. CNOs have been successfully applied in pharmacy and medicine due to their high surface area that is capable of adsorbing or conjugating with a wide variety of therapeutic and diagnostic agent (drugs, genes, vaccines, antibodies, biosensors, etc.).They have been first proven to be an excellent vehicle for drug delivery directly into cells without metabolism by the body. Then other applications of carbon nano involves supercapacitors , lithium ion batteries, fuel cells etc. CNOs have been recently revealed as a promising antioxidant.**[20]**

Fu-Dong Han and Bin Yao found that Carbon nano-onions (CNOs), which consist of concentric graphitic shells, represent another new allotropic nano phase of carbon materials Carbon nano-onions (CNOs) were prepared at 600 ˚C by a simple reaction between copper dichloride hydrate ($CuCl_2.2H_2O$) and calcium carbide (CaC_2). The morphology and structure of the obtained products were investigated by field-emission scanning electron microscope, high-resolution transmission electron microscopy, X-ray diffraction, Raman spectrum, and nitrogen adsorption. Large quantities of CNOs consisting of quasi-spherically concentric graphitic shells with high purity and uniform size distribution (about 30 nm) were obtained. The crystal water in $CuCl_2$, $2H_2O$ plays an important role in the formation of CNOs. The CNOs as obtained exhibit high capacity as anode materials for lithium-ion batteries.**[21]**

N. Sano and H. Wang concluded that the fabrication of carbon nanomaterials usually calls for expensive vacuum systems to generate plasmas and yields are disappointingly low. He described a simple method for producing high-quality spherical carbon nano-onions in large quantities without the use of vacuum equipment. The nano particles, which have C_{60} cores surrounded by onion-like nested particles, are generated by an arc discharge between two graphite electrodes submerged in water. This technique is economical and produces uncontaminated nano particles which may be useful in many applications.**[22]**

Atsushi Hirata reported that Tribological properties of carbon onions prepared by heat treatment of diamond clusters or particles are presented. Diamond clusters used as the source material are heated with an infrared radiation furnace to 1730°C in argon at atmospheric pressure. As a result of heating at 1730 °C for 1 min, diamond clusters are transformed into carbon onions. High resolution TEM observation is employed to confirm the formation of carbon onions that have near-spherical and multi-layered concentric structure. The particle size of these carbon onions ranges from 5 to 10 nm that corresponds to the original size of the diamond clusters. This preparation technique is also applied to diamond particles less than 0.5μm in diameter to produce larger carbon onions. Tribological properties of the carbon onions are examined by ball-on-disc type friction testing using a silicon wafer and a steel ball. Carbon onions, which are spread on the silicon wafer without adhesive, exhibit stable friction coefficients lower than 0.1 both in air and in vacuum at room temperature. The wear rates of steel balls sliding on the silicon wafer on which carbon onions are distributed are much lower than wear rates for sliding on a wafer over which graphite powder is spread. Moreover, it was found that the larger carbon onions prepared from diamond particles show low friction property on the rough surface of silicon discs. **[23]**

Amit Palkar *et.al* concluded that carbon nano particles obtained from either arcing of graphite under water or thermal annealing of nano diamonds are commonly called carbon nano onions (CNOs), or spherical graphite, as they are made of con-centric fullerene cages separated by the same distance as the shells of graphite A more careful analysis reveals some dramatic differences between the particles obtained by these two synthetic methods. Physicochemical methods indicate that the CNOs obtained from nano diamonds (N-CNOs) are smaller and contain more defects than the CNOs obtained from arcing (A-CNOs). These properties explain the enhanced reactivity of the N-CNOs in cyclo addition and oxidation reactions, as well as in reactions involving radicals. Given the easier functionalization of the N-CNOs, they are the most obvious choice for studying the potential applications of these multi-shelled fullerenes. **[24]**

P.Kuzhir found that microwave absorption properties of a novel electromagnetic material – onion-like carbon (OLC) produced by annealing of detonation nano diamonds in vacuum have been studied in microwave frequency range. The OLC electromagnetic (EM) absorption ability can be optimized by varying the nano carbon cluster size and nano diamond annealing temperature so that effective EM coatings can be produced. Attenuation of EM waves in the 26–38 GHz frequency range had been studies for both OLC powder and polymer composites. For powder samples it was concluded that OLC aggregates with higher conductivity (higher annealing temperature of the precursor nano diamond particles) and larger aggregate sizes provide higher efficiency for attenuation of the EM radiation. At the same time, when dispersed in a polymer matrix, more efficient shielding properties had been observed for OLC aggregates of the smallest sizes as compared to larger-sized aggregates at the same OLC loading. This is attributed due to the better dispersion and formation of a continuous conductive network by smaller aggregates. **[25]**

Chunnian He and Naiqin Zhao reported that Carbon onions with diameters ranging from 5 to 50 nm and carbon-coated nickel nano particles with diameters ranging from 10 to 60 nm have been synthesized on a large scale over Ni/Al catalyst by chemical vapour deposition. The approximate ratio of Ni-filled to empty onions as observed by TEM is 1:3.5. In order to eliminate the nickel nano particle and obtain pure hollow carbon onions, HNO_3 acid was used to dissolve the nickel from the carbon-coated nickel nano particles. The carbon onion particles thus obtained have hollow cores and are mainly composed of well-crystallized graphite, as characterized by high-resolution TEM and Raman spectroscopy. In addition a simple purification mechanism for Ni-filled carbon onions based on TEM observations was purposed.**[26]**

Qi Wang *et.al* found that Carbon nano-onions were prepared by burning castor oil. The as-prepared carbon nano-onions were characterized by scanning electron microscopy and transmission electron microscope to confirm the nano-onion structures. The carbon nano-onions were used as anodes for rechargeable Li-ion batteries and demonstrated high reversible capacity and relatively good rate capability. The electrochemical performance can be attributed to the unusual surface properties and unique structural features of the carbon nano-onion anode, which amplify both surface area and extensive intermingling between curved graphite layer over small length scales, thereby leading to fast kinetics and short pathways for both Li ions and electrons. **[27]**

Mohammad Choucair concluded that the combustion of naphthalene has been found to yield gram-scale quantities of carbon onions that are free of impurities and furthermore without the use of catalysts. X-ray diffraction (XRD) indicates that the interlayer spacing between concentric shells of the carbon onions is not uniform across the particle; rather it decreases from a graphite-like 0.34 nm and approaches a diamond-like 0.29 nm interlayer spacing towards the inner layers. The dispersion in the interlayer spacing is believed to result from differing external pressures exerted on the individual nanometer-sized graphitic membranes during formation of the onions. Electron microscopy techniques such as high resolution transmission electron microscopy (HRTEM) and scanning electron microscopy demonstrate the extensive formation of carbon onions. The HRTEM indicates that the onions consist of 50–54 shells, found to be in good agreement with the XRD data. **[28]**

Gang Wu and Mark Nelson reported that Nitrogen-doped onion-like carbon-rich materials were synthesized by heat treatment of a 'hybrid' containing hexamethylene diamine complex in the presence of Co and Fe species while preparing non-precious metal electro catalyst for oxygen-reduction. As demonstrated by electrochemical rotating disk electrode and fuel cell tests, the binary Co-Fe-based catalyst containing graphitized onion-like carbon nanostructures provides for improved performance relative to the single Fe-based catalyst in which no such carbon structure was observed. In the binary catalysts, variation of the ratios of Co to Fe and the total metal loading during the synthesis leads to a markedly different activity and four-electron selectivity for oxygen reduction. The optimized binary catalyst was studied in fuel cell lifetime tests using both constant current and voltage models, showing a good combination of activity and durability. Possible reasons for the improved performance of the Co & Fe-based binary catalyst are discussed. The graphitized onion-like carbon structure exclusively derived from Co in this work may be providing a robust matrix to host non-precious metal active sites, which would prevent water flooding of them, and increase the resistance to oxidative attack in the oxygen cathode, thereby leading to an improvement in performance durability. **[29]**

Joly-Pottuz and L Martin concluded that carbon nano-onions are the nano particles having a spheroidal shape and a nested structure. They can be used to simulate the presence of soot in used engine oils. When added to fully formulated fresh engines oils, these kinds of particles behave very differently. The addition of carbon onions in lubricant leads to a reduction of both friction and wear compared to pure base oil. This shows that there is an opportunity to control wear in engines by changing the structure of soot during the combustion process.**[30]**

Yiyang Liu and Doo Young Kim reported that electrode responsiveness and electrochemical capacitance behaviour of nano diamond-derived carbon nano-onions (N-CNOs) were studied. N-CNOs were prepared by thermal annealing of nano diamond powders. A thin film of N-CNOs was mounted on glassy carbon (GC) current collector and showed an excellent electrochemical behaviour with rectangular volta metric curves as well as great scan rate dependence of capacitance. The capacitance showed negligible drops over a wide range of scan rates (50 mV/s-5 mV/s) in both KCl and H_2SO_4. This excellent capacitive behaviour was attributed to good electrical conductivity and mesoporous nature of N-CNOs. In order to further enhance capacitance, electrochemical oxidation of N-CNOs was carried out by iterating anodic cycling in acidic electrolytes. The capacitance enhancement of oxidized N-CNOs was probed by cyclic voltametry as well as galvano static charging-discharging measurement. This study demonstrates that electrochemical oxidation can be an effective method to improve capacitance and energy density of carbon nano materials while maintaining a good scan rate performance.**[31]**

N.Q. Zhao *et.al* reported that Structural evolutions of carbon onions and carbon coated nano crystals of nickel during annealing process were investigated. X-ray diffraction, Raman and transmission electron microscope were used to investigate their structural variation. The results showed that annealing (700 °C) of the carbon onions resulted in the shrinkage of hollow core of carbon onions and reduction of the interlayer spacing between carbon onion shells. And the compressed onion structure took a perfect spheroidal shape. However, the structure of the annealed carbon coated Ni nano particles presented that the Ni nano particles (5–30 nm) escaped from carbon encapsulation and congregated to large Ni particles (30–180 nm), and the carbon coating was disintegrated to small disorder graphite pieces. When the Ni was removed from the carbon coated Ni nano particles and then was annealed at 700 °C for 4 h, it was found that these hollow carbon onions presented the similar structural evolution as the above carbon onions. **[32]**

X.W. Du *et.al* found that on the initial stages of growth of carbon onions synthesized by CVD (Chemical Vapour Deposition) of methane. A special experimental procedure has been developed to stop the process after short duration (10 s–2 min). It has found that during the early stages (90 s), carbon atom cluster encapsulated nano particles were formed. With increasing synthesis time (2 min), the carbon clusters began to graphitize to form graphitic layers. High resolution transmission electron microscope observations showed that many catalytic particles were partially encapsulated with graphitic layers, which were responsible for the hollow carbon onion formation. **[33]**

Junjie Guo reported that Carbon nanostructures are of considerable interest owing to their unique mechanical and electronic properties. Experimentally, a wide variety of different shapes are obtained, including both spherical and spheroidal carbon onions. A spheroid is an ellipsoid with two major axes equal and the term onion refers to a multi-layered composite structure. Assuming structures of either concentric spherical or ellipsoidal fullerenes comprising n layers, the interaction energy between adjacent shells for both spherical and spheroidal carbon onions was examined. It was found that the equilibrium spacing between shells decreases for shells further out from the inner core owing to the decreasing curvature of the outer shells of a concentric structure.**[34]**

Ruijun Zhang *et.al* concluded that Onion-like fullerenes synthesized by arc discharge in water were used as support of Pt nano particles as electro catalytic materials for direct methanol fuel cell. Uniform platinum nano particles with the average diameter of about 4.3 nm were well dispersed on the surface of onion-like fullerenes by impregnation-reduction method. The morphologies and microstructures of the as-prepared composites were studied by means TEM. Electrochemical analysis shows that this kind of nano material may be used as the support of catalyst for methanol electrochemical oxidation.**[35]**

Jiang Xu *et.al* found that Carbide-derived carbon (CDC) was prepared by the chlorination of the milled SiC powder at 800 °C. The microstructure of the produced carbon was analyzed by High-resolution Transmission Electron Microscope. The results show that there exist a large number of hollow carbon onions in the resultant CDC. Interestingly, all of these hollow carbon onions possess larger lattice spacing. The formation of such carbon onions can be attributed to the existence of the Fe in the SiC grain boundaries. Furthermore, the possible mechanism for the formation of the hollow carbon onions with larger lattice spacing was discussed. **[36]**

S.H. Sarijo reported that Carbon nano- and microspheres were synthesized using a dual-furnace chemical vapour deposition method at 800–1000 °C. Palm olein (PO) and zinc nitrate solution were used as a carbon source and catalyst precursor respectively. At 800 °C, no regular microspheres were formed, while a more uniform structure was observed at 900 °C and 1000 °C. Generally, the size of the microspheres is temperature-dependent. The carbon spheres are composed of graphite and amorphous carbon phases and the formation of amorphous carbon was found to be the optimum at 850 °C. This study demonstrates a successful method of carbon nano- and microsphere preparation using PO, a renewable bio-resource, as the carbon source for the production of carbon sphere. **[37]**

Yongzhen Yang concluded that Nano-carbon materials were synthesized by the catalytic decomposition of acetylene at 420 °C using iron supported on sodium chloride as catalyst. The catalysts contain about 0.3, 1.6, 3.3, and 5.2 wt% iron. The samples were examined by scanning and transmission electron microscopy, energy dispersive spectroscopy, and X-ray diffraction. The results show that nano onion-like fullerenes (NOLFs) surrounding an Fe_3C core were obtained using the catalyst containing 0.3 wt% iron. These had a structure of stacked graphitic fragments, with diameters in the range 15–50 nm. When the product was further heat treated under vacuum at 1100 °C, NOLFs with a clear concentric graphitic layer structure were obtained. The growth mechanism of NOLFs encapsulating metallic cores is suggested to be in accordance with a vapour–solid growth model. **[38]**

D.Avila Brande *et.al* reported that new carbon materials have been synthesized by chlorinating niobium carbide at different temperatures. During the reaction, the volatile niobium chloride, mainly $NbCl_5$, is formed and eliminated leaving the carbon in the shape of spherical particles. TEM examination of the remaining particles revealed that at 400 °C and 700 °C they are composed of a NbC core with an amorphous carbon shell outside. The NbC cores are very small (~20 nm) at 700 °C and they are not observed at 900 °C. Nano particles
without the NbC core present a more ordered structure composed of concentric wavy graphene layers. This structure seems intermediate between carbon onions and carbon blacks. The 900 °C sample presents a very high BET surface area (1292 m^2 g^{-1}) and the lower temperature samples exhibit a existence of large pores in the interspace between the NbC core and the carbon shell. **[39]**

Xiaomin Wang *et.al* reported that Carbon microspheres were synthesized from asphaltene by a chemical vapor deposition (CVD) method and characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), high-resolution transmission electron microscopy (HRTEM) and Raman spectroscopy method. The results indicated the monodispersed spheres were almost curving graphitic structure with diameters from 300 to 400 nm. G mode centre of carbon microspheres had shifted upward compared with graphite. As an efficient precursor, asphaltenes were metastable structures at higher temperature. The aromatic carbon rings of asphaltenes promoted the formation of closed cage graphitic structures. The results provide a new perspective for the application of asphaltene. **[40]**

Takuya Maie and Jun-ichi Ozaki concluded that In an attempt to obtain carbon catalysts with higher activity for the oxygen reduction reaction (ORR), a mechano-chemical (M)-treatment was applied to a heat-treated precursor of carbon nano-shell containing catalysts at 500°C, where the nano-shell was a catalytically formed, shell-structured carbon material with diameter of 20–30 nm and walls that consisted of hexagonal carbon layers. The precursor was a mixture of cobalt phthalocyanine and a phenol-formaldehyde resin. The carbonized precursor that was mechano-chemically treated after the heat-treatment at 500°C showed higher ORR activity, with ORR current density that was five times that of the carbonized untreated precursor. Characterizations of the precursors and the carbons concluded that the enhanced ORR catalytic activity was due to the formation of carbon nano-shells with disordered hexagonal carbon layers located on their surface, and these nano-shells had a higher N/C surface atomic ratio than those of the carbonized untreated precursors. The application of M-treatment to a 500°C-heat-treated precursor was thus revealed to be useful for improving the ORR activity of carbon nano-shells. **[41]**

Yiting Peng *et.al* reported that Fluorine-rich nanoporous carbons with excellent porosity and Flourine content have been successfully synthesized from a silane precursor using a solution-based Fluorine doping method. The Fluorine-rich carbon surface with higher polarity provides stronger affinity and wettability for the organic electrolyte, which is for the first time demonstrated though Gauss computational calculation between Fluorine-carbon surface and organic electrolytes. The optimized Fluorine-rich nano-porous carbon manifests a high specific capacitance of 168 F g^{-1} in a symmetric cell with excellent retention at high rates and upon prolonged 10,000 cycles. **[42]**

V. Dinesh Kumar and Priya Ranjan Prasad Verma concluded that Biodegradable nanoparticles have been used regularly as drug delivery carriers owing to its bioavailability augmentation, better entrapment, sustained release and biocompatibility. The present study aimed to compare the antibacterial efficacy of quercetin loaded nano-onions (QLNs) with free quercetin against **Bacillus subtilis, Escherichia coli, Staphylococcus aureus** and **Salmo- nella typhimurium** (food-borne microorganisms). Stability study confirmed insignificant variation in particle size, zeta potential and encapsulation efficiency over a period of 90 days of storage. High resolution-transmission electron microscopy (HR-TEM) showed the formation of spherical nano-onions with smooth surface. The antibacterial activity of free quercetin and QLNs were evaluated for zone of inhibition, percentage retardation of bacterial growth, kinetic measurement, minimum inhibitory concentration and minimum bactericidal concentration studies. The results indicated that QLNs were more efficient than free quercetin owing to control release of quercetin from nano-particles. The mechanism of antibacterial activity of QLNs was investigated by atomic force microscopy and scanning electron microscopy. Microscopic study revealed the adsorption of nano-particles on bacterial cell surface followed by increased cell permeability causing celllysis. **[43]**

Valerie Keller and Robert Schlogl found that the catalytic properties of sp^3-hybridized ultra-dispersed diamond and sp^2-hybridized onion-like carbon in the oxidative dehydrogenation of ethyl benzene to styrene formation were investigated, highlighting the structure sensitivity of the reaction. The sp^3-carbon led initially to C–C cleavage and benzene formation, while a switchover of the main reaction pathway into the styrene formation occurred with time on stream due to the formation of surface sp^2carbon, required for the selective styrene formation. This was confirmed by the behaviour and the high stable styrene selectivity shown by onion-like carbons. High temperature oxygen pre-treatment created catalytically active species at the sp^2 carbon surface, confirming that a high thermal stability carbon–oxygen complex was the active surface site for forming styrene. [44]

Marta E. Plonska-Brzezinska *et.al* reported that The electrochemical properties of small carbon nano-onions (CNOs) in the solid phase, non modified carbon nano-onions (n-CNOs) and CNOs functionalized with carboxylic acid groups [oxidized carbon nano-onions (ox-CNOs)] were investigated by cyclic voltammetry. The redox properties of CNO films depend on the functionalization of the carbon surface. In aqueous solutions, the n-CNO/tetra octyl ammonium bromide (TOABr) films show a behavior typical of an ideal double-layer capacitor with a specific capacitance. The ox-CNOs are electrochemically active at negative potentials due to carboxylic group reduction. Modification of the nano-onion surface with carboxylic groups results in a decrease in the specific capacitance of ox-CNO/TOABr films. **[45]**

V D Blank and V N Denisov reported that Carbon onions were formed in graphite in the diamond anvil high pressure cell under axial pressure combined with shear deformation at room temperature. The onions were ranging in size from 1–2 nm to 1–2 μm and HREM studies have shown that the amount of their concentric shells tended to increase with pressure and deformation growth. Raman spectra were taken from large-size onions. Narrow bands found between 1400 and 1550 cm ^{1} correspond to fullerene-related carbon materials. The splitting of the pentagonal pinch mode 1446–1489 cm ^{1}is considered to be connected with the formation of heptagon. **[46]**

Piotr Pieta *et.al* reported that Super-capacitors are energy storage devices known for their long life charge-discharge cycling stability, highly reversible charge storage ability, and high power density. Carbon nano-materials, particularly carbon nano- onions (CNOs) and graphene have been recognized as promising active materials due to their outstanding conductivity and large surface area, the two key requirements of superior super-capacitor electrode materials. Moreover, the composites of these nano-materials and different conducting polymers (CPs) are borne out to be even more promising for that purpose. The present article provides a critical review of the conducting composites made of the fullerene-based polymers belonging to the redox conducting polymers (RCP), the aniline, pyrrole and thiophene π-electron polymers of the electronically conducting polymers (ECPs) family and CNTs- and/or graphene-based structured nano-materials. Specific capacitance values up to ∼900 F g ^{1} were reported for some nanocarbon/CP composites indicating that they can be considered as future electrode materials for constructing charge storage devices. **[47]**

Sandesh Y. Sawant and Rajesh S. Somani concluded that the characterization of carbon soot obtained from the pyrolysis of different plastic wastes under static atmosphere showed the formation of carbon onions of 60±10 nm. Various physico-chemical studies have been carried out to explore the surface as well as bulk properties of carbon onions. The volume of heating chamber plays a crucial role on production and deposition of carbon onions. The pyrolysis of plastic wastes such as polypropylene, polyethylene (high and low density) and polyacrylate completely resulted into the carbon onions, whereas crystalline carbon residue with carbon onions was obtained with the pyrolysis of polyethylene terephthalate, polyvinyl chloride and polystyrene. **[48]**

Ming-Zhi Wang *et.al* reported that The onion-like carbons (OLCs) annealed at 900–1400°C were used as raw materials to synthesize additive- free nano polycrystalline diamond (nPCD) compacts in the industrial sintering conditions of 5.5 GPa, 1200°C, and 15 min. The results showed that the OLCs were transformed into additive-free D-D type nPCD compacts in industrial sintering conditions. The nPCD compacts contained a large number of nano twins. The purities and performances of nPCD compacts were homogeneous in three dimensions. The purity and physical and mechanical performances of the nPCD compact (denoted as $nPCD_{11}$) sintered from the OLCs annealed at 1100°C were the highest. During sintering process, the graphite layers of OLCs ruptured from inside toward outside forming larger nano diamond particles. At the same time, the OLCs bonded adjacent to OLCs forming additive nPCD compacts. **[49]**

Qiuxiang Wang *et.al* found that Carbon nano onions with a parallel growth mode were synthesized by a chemical vapor deposition (CVD) method using a nickel catalyst precursor and acetylene carbon source gas at 550 °C, the growth mechanism and growth model of which were discussed and established, respectively. In the case of no pre-treatment, the Brunauer–Emmett–Teller (BET) surface area and total pore volume of the as-synthesized carbon nanofibers were 214 m^2▪g ^{1} and 0.36 cm^3▪g ^{1}, respectively. The maximum specific capacitance of the carbon nano-onions was 205.8 F▪g ^{1}, examined at a 0.20 V▪s ^{1} sweep rate. The structure and morphology of the carbon nano-onions were characterized by field emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM) and x-ray powder diffraction (XRD).**[50]**

Simon and Gogotsi, Y. reported that The rapidly growing demand for capacitive energy storage systems for applications such as self-powered micro and nano systems, portable electronic devices, and large-scale stationary applications has inspired much research in an effort to develop devices that can provide high power and energy densities. The important factors affecting the performance of electrochemical capacitors (ECs) are the intrinsic properties of electrode materials and electrolytes, as well as the properties of their interfaces. There is no perfect electrode material and no ideal electrolyte that can meet the performance goal for every application. Therefore, a rational design of these materials is crucial for rapid advancement and widespread implementation of ECs. A large variety of nano structured carbon materials are available nowadays that can be used as electrode materials. Zero- and one-dimensional nano particles, such as onion-like carbon and nano tubes, can provide a high power due to fast ion sorption/desorption on their outer surfaces. Two-dimensional graphene has been receiving an increasing attention due to its higher charge-discharge rates compared to porous carbons and high volumetric energy density. Three-dimensional porous activated, carbide-derived and templated carbon networks, having a high surface area and porosity in the sub-nanometer or a few-nano meters range, can provide high energy density if the pore size is matched with the electrolyte ion size.While aqueous electrolytes, such as sodium sulphate, are the safest and least expensive, they have a limited voltage window. Organic electrolytes are the most commonly used ones in commercial devices. Non-flammable ionic liquids are attracting an increasing attention due to their low vapour pressure leading to a safe operation in the range from -50°C to at least 100°C and a larger voltage window resulting in a higher energy density compared to other electrolytes. Further advances in development of materials and understanding charged solid-electrolyte interfaces are expected to lead to a wider use of capacitive energy storage at the scales ranging from microelectronics to automobiles and electrical grid. **[51]**

Daniel Codorniu ***et.al*** found that The Raman spectra of polyhedral carbon nano-onions (PCO), obtained by underwater arc discharge of graphite electrodes, are studied. While the general Raman spectrum of PCO is very similar to those of other carbon nanostructures, including spherical nano-onions, the fine structure of the G and 2D bands gives the valuable information that allows using Raman spectroscopy for differentiating the PCO from other carbon structures. The interpretation of the features of the fine structure of the spectra is supported by evidences obtained by TEM. **[52]**

Fabing Su ***et.al*** concluded that the largely improved electrochemical capacitance of poly pyrrole-derived microporous carbon nanospheres (MCNs, 80–100 nm in diameter) containing nitrogen functional groups. The electrochemical properties of precursor poly pyrrole nano spheres (PNs, with a high N/C ratio and low surface area) and as-derived carbon nano spheres (CNs, with a moderate N/C ratio and low surface area) prepared by carbonizing
PNs at different temperatures, and MCNs (with a low N/C ratio and high surface area) obtained by chemical activation of CNs. The samples are thoroughly characterized by trans-mission electron microscopy (TEM), X-ray diffraction (XRD), Raman spectroscopy, thermo-gravimetric analysis (TGA), nitrogen sorption, elemental analysis, and X-ray photoelectron spectroscopy (XPS). It is found that MCNs with a high surface area and N-doping species exhibit much better capacitive performance compared to the PNs and CNs, and commercial carbon blacks as well. The MCN sample gives a reversible specific capacitance of ~240 F g ^{1} for 3000 cycles in aqueous media as a result of combined advantages of high electrochemical activity of doped hetero atoms (N and O) and accessible well-developed porosity, demonstrating the promising use in high-energy-density super-capacitors. **[53]**

L. S. Chen and C. J. Wang found that Synthesis of onion-like fullerenes was carried out by chemical vapour deposition in a tubular furnace using iron catalyst supported on aluminium hydroxide at 400°C, 460°C, 600°C, 700°C, 800°C, 900°C and 1000°C, respectively, in the presence of argon as carrier gas and acetylene as the carbon source. The samples synthesized were characterized by high-resolution transmission electron microscopy, and the effects of temperature on the morphologies of the samples were investigated. The results show that the onion-like fullerenes prepared at the low temperature 400°C had the highest purity and good quality. **[54]**

O. Shenderova *et.al* reported that Dielectric analysis of a novel polymer composite based on onion-like carbon (OLC) has been carried out by varying the temperature between 240 and 460 K within a wide frequency range (20 Hz–1 MHz). A small effect of the OLC inclusions on the beta transition of OLC/poly methyl methacrylate (PMMA) composite has been observed, which indicates a weak affinity of the OLC to the host matrix. At the same time, an increase in concentration of the OLC has been found to strongly influence the glass and melting temperatures of the nano composites. These structural properties of the OLC/PMMA composite materials should be taken into account when a new family of effective wide-band electromagnetic materials are designed and fabricated. **[55]**

S. S. Hou and W. C. Huang reported that The influence of flow rotation on the synthesis of carbon nano-structures using rotating opposed flow ethylene diffusion flames and a catalytic Ni substrate was investigated. In the experiments, the flame parameter was kept constant with fuel and oxidizer compositions of 20% C_2H_2+80% N_2 and 40% O_2+ 60% N_2 in the upper and lower burners respectively where as the strain rate was varied by adjusting the rotation speed. Stain rate affects carbon nano-structures synthesis either through the residence time of the flow or carbon sources available for the growth of carbon nano-onions (CNOs) and onions. A diffusion flame at low strain rate is stronger than a weak flame at high strain rate and produces more carbon sources because of the longer residence time of the flow. At a lower strain rate carbon nano-onions (CNOs) were synthesized. It is verified that flow rotation associated with residence time plays an important role in the synthesis of carbon nanostructures. **[56]**

DISCUSSION

In summary, we have demonstrated that the chemical activation is effective in creating porosity in outer shells of CNOs to improve the energy density and preserve the power density in CNO electrodes. After activating CNOs using a 6 mol/l KOH solution, a maximum specific capacitance of 122 F/g, power density of 153 kW/kg, and energy density of 8.5 Wh/kg were achieved. The same parameters for pristine CNOs are 25.8 F/ g, 123 kW/kg, and 1.5 Wh/kg, respectively. The enhanced electrochemical performance of CNOs is the result of the introduction of porosity (increased SSA) and the improved surface hydrophilicity due to the KOH activation. The activated CNOs display high charge/discharge rates at scan rates up to 5000 mV/s. A high capacitance retention ratio of 71% is preserved as the current density increased from 0.75 to 25 A/g. Additionally, the activated CNOs have a high knee frequency (825 Hz) and a smaller relaxation time constant (82.5 ms). In the same time, many hurdles of this nanotechnology have to be solved or elucidated. The human toxicity of different forms of CNOs for short- and long-term treatment is the first vital concern when they will be assayed in clinic. In conclusion, large quantities of carbon nano-onions have been successfully prepared by a simple and economical method via the reaction between $CuCl_2.2H_2O$and CaC_2. The formation of the CNOs is greatly associated with the crystal water in $CuCl_2$. $2H_2O$. The electrochemical performance testing gives some evidence that the prepared CNOs with a unique graphitic multilayer structure have intensive potential as a candidate of anode materials with high reversible capacity and good cycling performance for rechargeable lithium-ion batteries. We have studied optical extinction properties of the carbon onions prepared from diamond nanoparticles. Experimental extinction spectra of the spherical and polyhedral onions dispersed in distilled water were acquired by optical transmission spectroscopy. For spherical onions in water, a broad extinction peak emerged around 3.9 mm. On the other hand, polyhedral onions showed a spectrum with two peaks at 3.9 and 4.6 mm. In order to interpret these experimental results, we carried out semi-quantitative theoretical considerations. A new dielectric model, named the defective spherical onion model, was constructed for spherical onions. The calculations demonstrated that the aggregate of the defective spherical onions in water medium explains well the experimental features. The spectrum with double peaks for polyhedral onions can be reproduced successfully by assuming the aggregate of the onions as that of anisotropic graphite nanoellipsoids. In relation with the astrophysical context, the present calculation implies that defective spherical carbon onions are likely candidate for an origin of the interstellar extinction bump at 4.6 mm. New catalyst precursors (acetylacetonates of copper and nickel) for CNO syntheses have been successfully demonstrated. CO disproportionate in the presence of nickel particles yielded carbon nano onions, given that the residence time and temperature in the reactor, together with the carbon monoxide concentration, were adequate The produced carbon nano onions were spherically layered and upto 10 nm in diameter. Small amounts of the amorphous carbon coating were observed on the carbon nano onions.

The presence of the copper catalyst particles resulted in the formation of carbon nanoparticles, which were from 5 to 30 nm in diameter and consisted of concentric carbon layers surrounding a hollow core, i.e. carbon nano-onions were produced as the primary product. Thus, the new method for carbon onion production was demonstrated here for the first time. On the basis of these experimental results, the mechanisms for the formation of CNOs were discussed. Carbon nano-onion (CNO) is an important member in the family of carbon allotropes. Owing to the novel structure, potential applications of CNOs for nano lubricants, magnetic storage materials, and single electron devices, point source field emitters, and electrochemical capacitors etc. have been suggested. Up to now, various physical and chemical methods have been employed successfully for the synthesis of CNOs, such as arc discharge, laser ablation, plasma method, chemical vapor deposition (CVD) and high temperature annealing, etc. Due to the advantages of low cost, the simplicity of operation and the ability in the controllable growth of product structures, CVD becomes one of the most promising approaches for producing CNOs with high purity in large quantities . Transition metal particles, as well as bimetallic alloy particles containing transition and other metals, such as Ni–Fe, Fe–Co, M–Cu and M–Al (M presents the transition metal), etc. have been extensively recognized as excellent catalysts in the decomposition of hydrocarbon gas and the synthesis of carbon products. Compared with nickel or iron catalyst, the Ni–Fe alloy catalyst provides a promoted effect and leads to a larger yield in the growth of carbon nano onions.

Concludatory Comments

Multi-shell fullerenes known as carbon nano-onions represent one of the least studied carbon nano materials. The foregoing review shows that therapeutic agents which are poorly soluble absorbed poorly and that are labile can be converted into promising forms which can be delivered through different routes of administration. It has various advantages simultaneously and also has some limitation such as can be immunogenic and others. The physio-chemical parameters of the drug play an important role in the selection of the nano particle material that has to be employed. Various methods can be used for the preparation of carbon nno onions depending upon need. Characterization of them is must for better therapeutic response. Currently application of Nano onions is widely spread which are providing their service to humans were studied in detail.

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