# Review on Characteristics and Application of Titanium Carbide

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***Abstract*-** *The Nano particles are smaller elements of average size ranging between 1-100 nm. They are capable of bonding with the polymers and other materials to increase their properties. Among which Titanium carbide is a suitable enhancer of properties from the original state to expand the applications in various fields like optical, biomedical, agriculture, ceramics, etc. Titanium carbide itself provides additional strength to the products.*

***Keywords*-** Titanium carbide, characterization; applications; property testing.

## I. INTRODUCTION

Titanium carbide (TiC) nanoparticles are having good conductivity and good chemical inertness which belongs to the classification of Titanium (Ti) to block D period 4 and carbon (C) belongs to block P period 2 having the weight percentile of Ti-79.91% and C- 20.3% with having the appearance of Black color and <200 nm of particle size(TEM). They are mostly used in cutting and wear resistance tool applications instead of tungsten carbide, in optical applications and as a nucleating agent, etc. It should be stored in cool, vacuum and stress free condition.

***Characteristic of Titanium carbide:***

Titanium carbide has the melting point of 3160$^o$C and boiling point of 4820$^o$C. The density and molar mass of the TiC are 4.93 g/cm3 and 59.98gm/mol. The thermal conductivity 5.64W/mk and youngs modulus is 310.34 -379.31 GPa at 100 at the condition of 1000$^o$C of ceramic. Titanium carbide and tungsten carbide are melted by Arc plasma melting method to form composite is used in [1]. TiC is used in six different composition with the range of 1-15% with the WC to find the different characteristics of the composition. From the melting process of WC there is increase in hardness number of 3650 ± 75 VHN for WC-12 (WC + 15 wt% TiC). The youngs modulus is increased a very high of range of 540-700 GPa and also improved in the hardness number when they get melted which form a stronger composite. when there is increase in TiC in the composition the hardness get increases and used in various applications of cutting tools, engines seals, grinding wheels, etc. The austenitic stainless steel is coated by titanium carbide dispersed coating by laser alloying is used in [2]. A light transmitting resin alloy coating is used by TiC by the reaction of Ti and pyrolytic carbon in the molten pool to increase surface hardening of the stainless steel by the laminated by the titanium foil and transparent adhesive and increase of the value of 1200 HV at the average power increase and finally the microstructure is also found with B2 increased intermetallic phase to increase the surface cracking.

Panzhihua ilmenite produced the high purity TiC in [3] which has large amount of magnesium and silica. >99 wt% of high purity titanium carbide is prepared by the various steps of carbon thermal reduction, followed by acid and alkali leaching methods. The preparation reduces the shorter reaction time with low reacting temperature and carbon ratio will produce a size of 1-20mm and Dv50 was 5.29 mm. Thus TiC is purely prepared by the various methods with their respective particle sizes. A new method of modeling titanium carbide derived carbon is used in [4] the residual generation of titanium by modified atmospheric structures followed by removing carbon, adding carbon and Ti to form a new atomic scale carbide derived carbon structure to produce the properties of structural and adsorption isotherms on the basis of experimental data. There will be overall gas adsorption from the interaction of carbondioxide gas from other residual metal based porous structure.

A supercapacitance performance of the decorated TiC by dopamine derived N doped carbon in [5]. The electrical conductivity and chemical stability of two dimensional carbides and mxenes by low capacity development and other applications. The two different composition are prepared to check the properties and other dimensions. The fist composite prepared is manifested and decorated on the surface and interlayer of the sheets of Ti3C2Tx to form a three dimensional composite nano structure and provides a good conductivity and pseudocapacitance in the optimized state of composition mixture of the composites than the second achieving supercapacitance in the high power and density. Thus the calcination process is done on two different composition and provides the enhanced electrochemical and high supercapacitors in the nitrogeb=n doped carbon composites. In [6] the hydrogen is inserted in TiC by two methods of the carbide must closes to TiC0.60, as hydrogen need some vacancies of carbon to penetrate the carbide and in ordered of carbonvacancies to emerge the hydrogen. At the condition of 730'c and annealing for 40h hydrogen penetrates in the carbide and get stored on the sub stoichiometric TiC and it has the best advantage than other metals having low density and higher chemical inertia as they are in fine powders and used in other applications.

Synthesized submicron powders of TiC are sintered through low pressure in [7]. The utilization of TiC by the method of densified to relative density of ~ 95.7% at 1700 °C with grain size of ~ 5.5±0.7 µm. By increasing the drive force the moderate Vickers hardness ranges of ~ 20.3±1.3 GPa, and high flexural strength of ~ 383.5±20.5 MPa is produced under sintered high temperature than the literature results. The growth morphology of MC carbides are evaluated by the TiC powder layers in [8] by pulsed surface alloying technique. The phases are identified by the XRD, EDS and SEM is used for microstructure scanning in which the powder get dissolved in the molten pool and different morphologies are prepared in cooling cycles where the precipitation from the thermodynamic calculation increases the concentration of titanium and carbon in the melt increases the thickness the layer of composite and different cross shaped morphology are formed by the secondary carbides which tends to the Chinese script shape grain boundaries in the position of molten pool without affecting the secondary morphologies.

The investigation of Ti-TiC binder is done by the electron beam overlaying in [9]. The composite has been produced from selfpropagating hightemperature synthesis in the Ti and C powder mixtures and various test are taken such as SEM and XRD and other the characterization of the composites of the hardness and abrasive wear resistance increases than the titanium by 3.7(2.2) and 21.6(13.8) times by reducing the wear out of inducing the binders with the weak bond matrix and recrystallization process of cladding pool melt process. The mechanical and metallic properties of TiC in [10] having high hardness and refractory property are tested under three pressure of 0 GPa, 30 GPa and 50 GPa. The phase diagram of the element is checked in 0 K was formed as composition and concentration are also founded. There is a higher concentration when average valence electron density and tactility, while decreases when covalent bonding directionally added to it and Ti seems to be directly affect by the metallic properties of the metal. The TiC is deposited on the copper substrates by magnetron sputtering in [11] at the constant room temperature and the crystalline cube is analysed by the XRD at the capacity of 169 µA h g−1 and volumetric studies the oxidation and reduction of 1.1V and 0.78V. There is a decrease in discharge capacity and XPS analysis of lithium intercalated film shows the unwanted phases like titanium oxide and LiF and others. The SEM images shows the grain structure of unequilised of 15-20 nm and thus the titanium carbide films has low homologous temperature to form the larger columnar grain size which is suspected to have improved the half-cell capacity.

In gas phase bromination of TiC micropowder are synthesized to form carbide derived carbon in [12] and the materials of carbon produced have high specific surface area and micropore volume in the results of successful $Br_2$ and $Cl_2$ of thermochemical extraction. The product having does not have the size of halogen and but the micro porosity of TiC-CDS is formed by the reactivity of titaniumhalide to the halogens and the volume of micropores is below 1.75 at -195.8°C where the total hydrogen uptakes a linear correlation on the specific surface area at 60 bar. The most important transition metal carbide is TiC used in [13] is combined with carbon nano fibers to form TiC-CNFs (TCNFs) films by synthesis technique to avoid the denaturation and leaking of electrodes from the enzymes which provides robust adhesion and large quantity in the structural integrity. When TCNFs is applied for glucose oxidase immobilization and biosensing leads to form a flexible with porous nature mobilizes electron transfer and good conductivity. The prepared biosensor has good sensing operations, wide linear range of (0.013-10.5 mM, R2 = 0.999), a low detection limit (3.7 µM, S/N=3) with good reproducibility, selectivity, anti-interface ability having the effective electrochemical biosensor.

TiC is reinforced with Al alloy (A 6603) composite is done by stir casting method in [14] where the TiC is added in the percentages of 2, 4, 6, 8, 10 in Al alloy and all the mechanical properties are tested. SEM, XRD were are also employed for the study of fracture and phase identification respectively are results in plastic deformation and free from intermetallic of composite. When there is an increase in TiC will decreased the impact strength of 31% and elongation of 35% from the original value. All the mechanical properties has increased in properties by adding the TiC. The microstructure of fractured specimen are characterized by particle fracture, ridges, voids and they are used in various applications. A photo crosslinked composite hydrogel composite of salecam network and TiC in [15] is prepared successfully and XRD shows crystal planes of Ti and the Tic nanoparticles are reinforced into hydrogel network to form structure where improved the mechanical and thermal stability of hydrogels. The swelling morphological behavior were affected by salecan content of maximum water uptake of 12.0g/g and the large pore size of 88.6 µm. Test are reveal to TiC nanoparticles addition with salecan was an effective approach to thermal stability by TGA and compression test and mechanical behavior shows the applications of soft tissue engineering.

Powder processing technique and sol gel process are combined the TiC coated with $ZrB_2$ in [16] for producing the composite with spark plasma sintering process. The TiC are sintered with $ZrB_2$ concentrated of nanosize of 1-2 μm to improve the densification of $ZrB_2$ and the difference in coefficient of thermal expansion will form a weak bonding interface. When toughening mechanism undergoes a crack deflection is formed via TiC in $ZrB_2$ matrix and consumption of energy when second phase bonded with the matrix.

TiC–CNF are prepared by electrospinning process in [17] for studying the mechanical and conductivity. It has thermal stability of 900$^o$C in nitrogen and 446 GPa of youngs modulus of single fiber and bended to 200 cycles with no significant damage. The electrical conductivity maintained to 96% and 92% when felt to bended for 60 and 100 cycle which all properties used for applications of high temperature resistant composites and flexible electronics devices. $Si_3N_4$ and TiC has been synthesized from sonochemical method to form nano ceramic powders in [18] at facile and safer way. The silicon nitride and TiC powders are reacted with $Si_3N_4$ and $TiO_2$ with activated carbon in liquid ammonia for 1 hour using ultrasound at 20 KHz. The product are scanned in SEM and XRD for phase composition and size distribution analysis of samples founded with diameter of 76nm for $Si_3N_4$ and 126.95nm for TiC with the surface areas of 803.67m$^2$/g and 731.78m$^2$/g.

TiC are sintered pressureless in Boron and Boron carbide in [19] at temperatures of 2100˚C to 2300˚C. At removal of oxide impurities the temperature of TiC is lowered to 2100$^o$C and fully dense TiC ceramic were obtained at 2200$^o$C and titanium boride and graphite plates are produced in the sintering process. The density is higher than the (>99.5%) than pure TiC (96.67%) at 2300◦C and the mechanical properties having high fracture toughness of (4.79 ± 0.50 MPa m1/2) and flexural strength of (552.6 ± 23.1 MPa) have been obtained when TiC mixed with $B_4C$ by the mass ratio of 100:5.11 which include the toughening mechanism of crack deflection and pull out titanium boride platelets. A submicron sized TiC powder has synthesized in combustion process in [20] with $TiCl_4$ and hexachloroethane as reactants with reducing agent as Mg. X-Ray analysis and high transition electron microscopy shows TiC cubic phase and particles are coated with low ordered carbon film on the surfaces and free carbon are removed by melting process with calcium at 865$^o$C to convert the carbon into calcium carbide with HCl and scaled size of TiC powder.

## II. CONCLUSIONS

Thus the properties of Titanium carbide increases the properties when embedded with the polymers to give a toughness material and extra addition will cause loss of material and various test are taken to identify the phases and composition of the mixed product and comparing the properties to the normal properties and TiC fulfill the properties to the required of the product.

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