



Electrical characterisation of SiO₂-TiO₂ nanocomposites for MOS capacitor applications

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Abstract: TiO₂-SiO₂ composite films (suitable adjustment of TiO₂ and SiO₂ compositions) showing a natural super-hydrophilicity and an optimal persistence of this property in absence of any UV light. From physico-chemical and morphological studies indicate that, though porosity and roughness effects cannot be excluded, wettability performances of composites films probably essential result from TiO₂-SiO₂ granular interface effects. Different composition of titania(TiO₂) and silica(SiO₂) nanocomposite films has been deposited on silicon wafer to prepare the MOS capacitor in clean room. Then the TiO₂-SiO₂ nanocomposite films has been characterised using Impedance meter and Hg pump by electrical techniques e.g., capacitive measurements and other physical magnitude (fixed and mobile charges, ability of physical traps to exchange electrical charges and the effect of excitation frequency and of the applied bias) extracted and analyzed with theoretical result. Where at higher biasing voltage compare to lower biasing voltage obtained near the same capacitance as theoretical values. But at higher biasing voltage obtained capacitance shows the dissimilarity with the dielectric properties of nanocomposites and it was unexpected. This result may be due to breakdown occurred, at higher biasing voltage. The target of this work is to use a silica-titania thin film that will exhibit natural super hydrophilicity in absence of any UV light and also need to persist this property for a long time. The correlation between super-hydrophilic properties and the dielectric behaviour of this nanocomposite noted 60% silica (SiO₂) in thin film shows good candidate for MOS capacitor.

Keywords: Nanocomposites(TiO₂-SiO₂), Superhydrophilicity, Persistent, MOS capacitor, C-V measurement

I. Introduction

Titanium dioxide (TiO₂-anatase polymorphic form) shows a good super hydrophilicity in the presence of UV light and also the surface with enhanced cleanability. But problem is that the photo induced super hydrophilicity of TiO₂ rapidly vanishes when the surface is stored in the absence of UV light. This is the main barrier to commercialize of TiO₂ as in indoor applications. But recently various studies show that this limitation of titania (TiO₂) can partially be overcome by adding a silica (SiO₂) component in crystalline TiO₂ films. XPS analysis noted that when the percentage of silica increases in the composite films then the carbon contamination decreases and as a result TiO₂-SiO₂ composite films not only exhibit an unexpected natural super-hydrophilicity, but this property can also persist for a long time without UV light [1, 2]. As a result, suitable adjustment of titania-silica nanocomposites can be used as a good oxide in MOS capacitor.

Metal Oxide Semiconductor (MOS) Capacitor

In (fig. 1) illustrated n type MOS or nMOS capacitor where p type semiconductor substrate and the oxide layer is formed using spin coating deposition methods and metal electrode is evaporated on top of the device that is referred to as the gate. Other end of the substrate has ohmic contact and it is also called bulk contact.

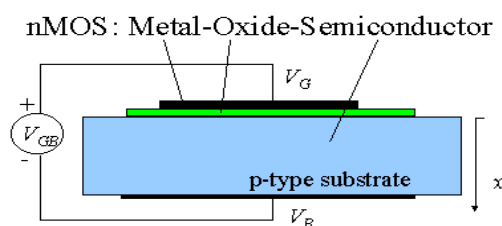


Fig. 1: nMOS Capacitor [3]

In general the oxide could be any large band gap insulator because the main purpose of the oxide layer are to make isolation between the metal and the semiconductor so that there is essentially no current flow between the top metal contact and the semiconductor. Where, SiO₂-TiO₂ nanocomposite film could be used for long

persistent. The capacitance of the MOS structure depends on the applied voltage (biasing voltage) to the gate. V_G is an applied voltage to the gate (fig. 1) while the body is grounded and the applied voltage V_G is more accurately V_{GB} , where V_G & V_{GB} are using interchangeably in this document. Based on, the polarity and magnitude of the applied voltage, the carrier concentration and band structure of semiconductor changes [3, 4]. When the applied gate voltage $V_G = 0$, the energy bands are flat and called flat band condition. Starting from the flat band position of an ideal MOS capacitor, three important regimes of biasing conditions are present in the semiconductor e.g., (i) Hole accumulation (ii) Depletion and (iii) Inversion regimes. These three regimes are important and reflected in the Capacitance-Voltage(C-V) characteristics curve. In the accumulation region (negative V_G) where the holes accumulate at the surface and ($C_s \gg C_{ox}$) because small change in bias causes a large change in charges in accumulation regime. When the gate voltage becomes positive and the channel is depleted of holes, where the depletion capacitance become important. If further increased the bias, the free electrons start to collect in the inversion regime and the depletion width remain unchanged with bias. Semiconductor capacitance C_s again increases and the capacitance of the MOS devices thus returns towards the value of oxide capacitance C_{ox} [4].

Capacitance -Voltage(C-V) characteristics of MOS structure

Capacitance as a function of the applied voltage is an important consideration of the MOS structure because it provides the important characterisation tool to check the quality of the structure. The measurement of the MOS capacitance (also called gate capacitance) varies with the applied gate voltage shown in (fig.2).

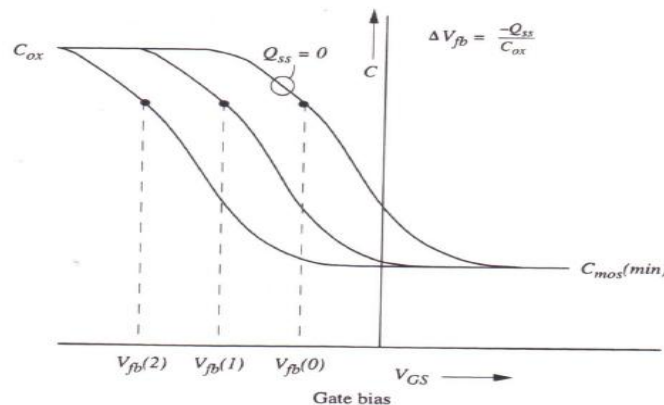


Fig. 2: High frequency capacitance voltage of MOS capacitors with different values of the fixed oxide charge

In C-V characteristics measurements, any dc bias is applied to the gate and a small ac signal (approximately 5-10 mV) is superimposed to obtain the capacitance at the bias applied. Normally at high (1MHz) or at variable frequencies between (1kHz to 1MHz) are used to measure the capacitance. The capacitance of the MOS structure is treated as the series connection of C_{ox} and C_s , as shown in (fig. 3).

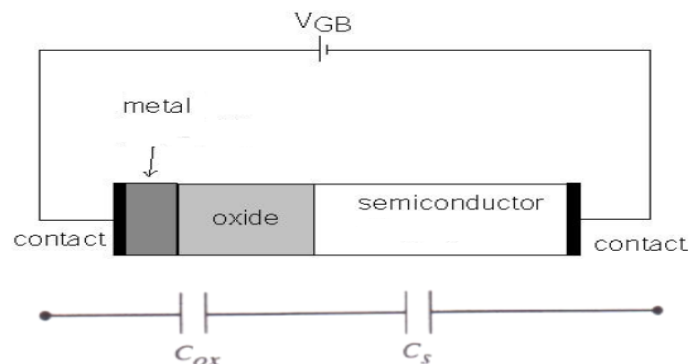


Fig. 3: A simple equivalent circuit of the MOS capacitor[3]

Flat band capacitance/voltage and average charges from CV curve in DSC(Double Stair Case)

Capacitance: The electrical behavior of the MOS structure is capacitive, since it store charges. The charge on the MOS capacitor varies nonlinearly with the gate voltage. The capacitance values per unit area can be written as from the (fig.3) for semiconductor

$$C_s = \frac{dQ_s}{dV_s}$$

Flat band capacitance (C_{fb}): From the (fig.3), flat band capacitance for series connection can be written as

$$\frac{1}{C_{fb}} = \frac{1}{C_{ox}} + \frac{1}{C_s(fb)}$$

$$C_{fb} = \frac{C_{ox}C_s}{C_{ox} + C_s}$$

So, in both of the cases (voltage and capacitance) one special condition is the flat band condition. For an ideal MOS capacitor, when the applied gate voltage $V_G = 0$, then this type of band is called flat band and in the case of capacitance is called flat band capacitance C_{fb} [3]. From the above flat band capacitance equation

where

$$C_s = \frac{\xi_0 \xi_s \times S}{\lambda},$$

$$\lambda = \text{Debye length} = \sqrt{\frac{\xi_0 \xi_s \times kT}{e^2 \times N_A}}$$

ξ_0 = Permittivity of free space

ξ_s = Dielectric constant of semiconductor

$= \xi_0 \times 11.9 \rightarrow$ Dielectric constant of Silicon

$S = \text{Surface area} = \pi R^2$, $R = \Phi/2$ and $\Phi = 790 \mu\text{m}$

$e = \text{Charge of electron}$

Av. Charge, $\Delta Q = C_{ox} \times \Delta V_{fb}$

$$\text{and } C_{ox} = \frac{\xi_0 \xi_r S}{t_{ox}}$$

t_{ox} = Thickness of the oxide

ξ_r = Dielectric constant of oxide

k = Boltzmann constant

T = Room temperature and

N_A = Doping density of semiconductor
(10^{16} at/cm^3)

Capacitance C_{ox} considers the maximum capacitance from the CV curve during forward bias in DSC (Double stair case). After measuring the flat band voltage, average charges are calculated. Due to the presence of fixed charge simply cause a voltage drop across the oxide is given by

$$\Delta V = \frac{-Q_{ss}}{C_{ox}}$$

Where, Q_{ss} is the fixed charge density (cm^{-2}) in the oxide region. If Q_{ss} is positive then the whole C-V curve shifted to a more negative value because the charge Q_{ss} is not dependent on the gate bias and the entire C-V curve shifting shown in (fig 2). By measuring the shifting as compared with the calculated ideal curve, the value of Q_{ss} can be obtained. Such measurements of charges are very important for characterising the quality of MOS devices.

II. Sample preparation (Elaboration of TiO_2 - SiO_2 coatings)

Silica-Titania nanocomposite films containing different ratios e.g., 20, 40, 60 and 80 mol% of SiO_2 were deposited from mixtures of a TiO_2 anatase crystalline suspension and polymeric SiO_2 solutions. At first a polymeric mother solution (MS) was prepared by mixing tetraisopropyl orthotitanate (TIPT) with deionised water, hydrochloric acid, and absolute ethanol as a solvent. TIPT concentration in the solution was 0.4 M, and the TIPT/ H_2O / HCl molar composition was 1/0.82/0.13. After aging the solution at room temperature, for two days before to use, then a crystalline suspension (CS) of TiO_2 nano-crystallites in absolute ethanol was prepared from the MS using a multistep procedure briefly shown the sol gel processes in (fig.4). For our experimental purposes (electrical characterisation) we prepared six types of nanocomposites sample including pure titania and pure silica. Where four silica solutions labelled S1-S4 were mixed in (20, 40, 60 and 80)% Si/(Si+Ti) molar ratios with the crystalline suspension yielding TiO_2 - SiO_2 solutions which were used in composites film deposition[1,2,5].

Sol-gel process

Wet chemical process based on inorganic polymeric reactions from metal alkoxides $\text{M}-(\text{OR})_n$ precursors are explained as follows:

• Hydrolysis: $\text{M}-(\text{OR})_n + \text{H}_2\text{O} \rightarrow \text{HO}-\text{M}-(\text{OR})_{n-1}$

• Condensation : $(\text{OR})_{n-1}-\text{M}-\text{OH} + \text{HO}-\text{M}-(\text{OR})_{n-1}$

$(\text{OR})_{n-1}-\text{M}-\text{OR} + \text{HO}-\text{M}-(\text{OR})_{n-1} \rightarrow (\text{OR})_{n-1}-\text{M}-\text{O}-\text{M}-(\text{OR})_{n-1}$

Mixed solutions were stirred for 30 min and then film deposition was performed on Si(100) wafers by spin-coating (300 μL of solution where the spin-speed has been used 3000 rpm) at room temperature. Prior to deposition, the substrates were cleaned by using ethanol, and then dried with air spray.

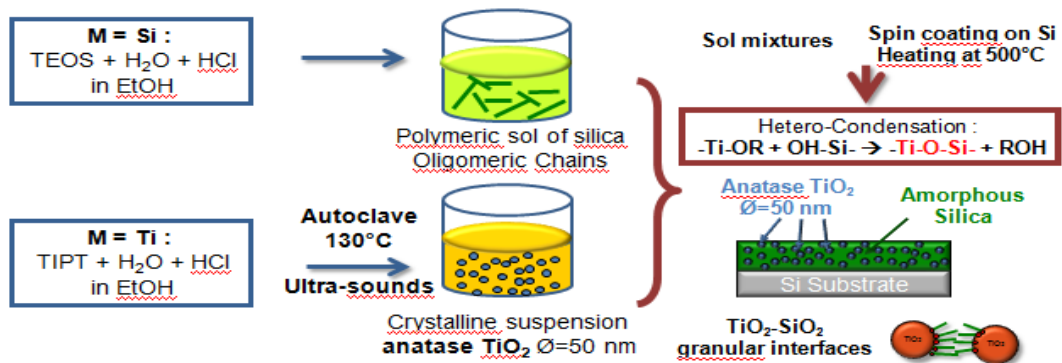


Fig. 4: Sol-gel process

This cleaning is sufficient to produce composites films of very good homogeneity and optical quality without local heterogeneities which might eventually influence surface wettability behaviours. Finally, deposited films were then heat-treated for 2h at 500°C. Resulting composite films thickness varied between 30 and 70 nm. These thickness variations are mainly related to differences in silica solution concentration (e.g., S1,S2, S3 and S4).

III. Characterisations (wettability measurements of the nanocomposites)

Surface hydrophilicity of the films is usually quantified by measuring the water contact angle. *M. Houmard et al.* performed one experiments at room temperature (e.g., 20°C) within an environmental chamber using KRUSS G10 goniometer connected with a video camera to measure the water contact angle at different points on the thin film surface. Measurement shown in fig. 5, ($\theta_{\text{composite}} \ll \theta_{\text{TiO}_2}, \theta_{\text{SiO}_2}$) where the water contact angle of the composite films is much less then the pure titania or pure silica. The beneficial effect of this nanocomposite is due to $\text{TiO}_2\text{-SiO}_2$ granular interfaces on persistent wetting properties

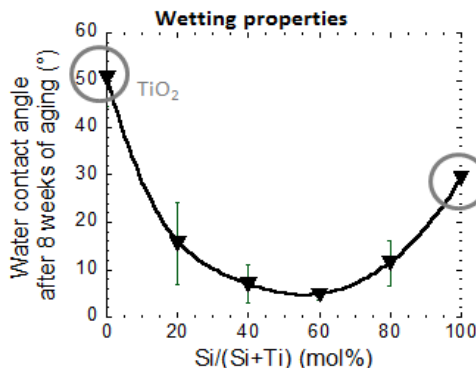


Fig. 5: Water contact angle after 8 weeks of aging

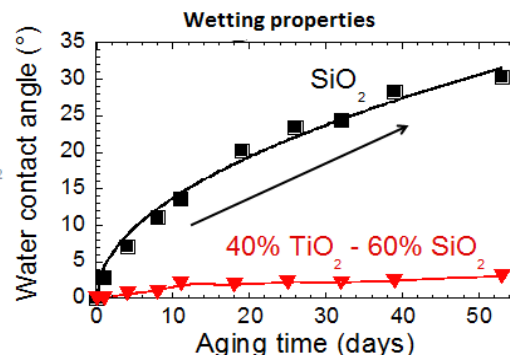


Fig. 6: Aging kinetics under ambient atmosphere without UV

Fig.5 shows that an optimal super-hydrophilicity persistent is obtained for a $\text{Si}/(\text{Si} + \text{Ti})$ solution composition of 60 mol%. Consequently, it appears that S2-40 and S3-60 maintain their initial super-hydrophilicity for eight weeks or more, i.e., in this case the films exhibit water contact angle is 5° or less after eight weeks. And this behavior was evidenced without any UV exposure over aging. But, after long time aging when the percentages of silica increases (more than 60%) then again composite films start to loss its super hydrophilicity, which is little contradiction with carbon contamination decreases with increasing % of silica[1,2](further study is ongoing). Enhanced of super hydrophilicity (measuring by water contact angle) of nanocomposite film shown (fig. 6), and also development on enhanced cleanability surfaces for indoor applications without UV light. Production of natural and persistent super-hydrophilic titania-silica nano-composite films [6] has shown in (fig.6) and also shows the comparison of super hydrophilicity with SiO_2 thin film (Harris, Baker et al. 1999).

IV. Experimental procedure for electrical characterisation

After plugging the main power line of impedance meter, connection has been completed (low and high potential of impedance meter with Hg probe). Switched on the impedance meter and connected light controller device with Hg probe. Then the Hg pump switched on and opened the cover (upper part). After cleaning the sample using spray has been placed on the sample holder inversely by tweezers. Where, the back side must contact through the center of the sample & sample must be in regular shape on the sample holder and also sample must cover the vacuum pump. Then the Lever has been brought in (intermediate state) and after waiting few seconds connection has completed. The sample has been contacted with mercury carefully to avoid touching any other part without lever. Then after closing the cover (upper part) of the Hg probe CV measurement has completed.

Same experiment has performed 4 corner position of the same sample. Following the similar procedure CV has been measured for all the sample.

Lab view program

CV measurement (Single & Double stair case): Switching the computer on, biasing voltage has been selected in between (-10.0V to + 10.0V), where the biasing voltage range can be used (-40V to +40V). Then step voltage (0.5V) has been selected. It will be negative value when the biasing voltage will select from higher to lower value, depend on scanning mode. Frequency has been selected 100 kHz and delay time usually 1.00 or 0.100 sec. CV measurement model was fixed at CPG (Capacitance parallel with conductance). Switching the light controller device on followed software command, where switched lighting on, then click OK, again switch off & click OK(during run the program the lighting is off). Then the experiment has carried out at (-2 to +2V) biasing voltage. Again the experiment has completed for double stair case, where CV curve look like hysteresis loop.

V. Experimental Results

First run (biasing voltage -10 to 10 V)

Table 1: **Sample (Pure titania);** Capacitance, flat band capacitance and average charge calculation noted for pure titania. Average values of capacitance & charge also calculated for different position of the same sample.

Position of sample on Hg probe	Capacitance C(pF)		Flat band voltage $\Delta V_{fb}(V)$	Charges $\Delta Q_{ox} = C_{ox} \cdot \Delta V_{fb}(C)$
	C_{ox}	C_{fb}		
Center	122	111	0.2	2.4×10^{-11}
Corner 1	103	95	0.1	1.0×10^{-11}
Corner 2	103	95	0.6	6.2×10^{-11}
Corner 3	90	83.93	0.3	2.7×10^{-11}
Corner 4	Missing			
Average values	104.5			3.1×10^{-11}

Similarly for all of the samples (e.g., 20, 40, 60, 80 and 100)% SiO₂ on composite film has been calculated the different parameter. Following the tables shows only for 60 and 80% SiO₂ nanocomposites. Then the average charges and capacitance calculation for all of the samples, noted in table (4) and graph in (fig. 7).

Table 2: **Sample (60%-SiO₂);** Capacitance, flat band capacitance and average charge calculation

Position of sample on Hg probe	Capacitance C(pF)		Flat band voltage $\Delta V_{fb}(V)$	Charge $\Delta Q_{ox} = C_{ox} \cdot \Delta V_{fb}(C)$
	C_{ox}	C_{fb}		
Center	571	391	0.45	2.6×10^{-10}
Corner 1	528	370	0.9	4.8×10^{-10}
Corner 2	Missing			
Corner 3	500	356	0.25	1.3×10^{-10}
Corner 4	530	371	0.75	3.0×10^{-10}
Average values	532.25			2.93×10^{-10}

Table 3: **Sample (80%- SiO₂);** Capacitance, flat band capacitance and average charge calculation

Position of sample on Hg probe	Capacitance C(pF)		Flat band voltage $\Delta V_{fb}(V)$	Charge $\Delta Q_{ox} = C_{ox} \cdot \Delta V_{fb}(C)$
	C_{ox}	C_{fb}		
Center	500	356	3.8	1.9×10^{-9}
Corner 1	700	447	4.6	3.2×10^{-9}
Corner 2	837	500	4.6	3.9×10^{-9}
Corner 3	830	497	4.4	3.7×10^{-9}
Corner 4	830	497	4.6	3.8×10^{-9}
Average values	739.4			3.3×10^{-9}

Table 4: **Average charges and capacitance according to composition of silica in TiO₂-SiO₂ nanocomposites**

% of Silica in nanocomposites	Charge $\Delta Q_{ox}(C)$		Capacitance $C_{ox}(pF)$	
	average	Std. dev.	average	Std. dev.
0	0.3×10^{-10}	0.22	104	13.2
20	2.6×10^{-10}	1.7	118	14.5
40	2.11×10^{-10}	1.98	211	180.5
60	2.93×10^{-10}	1.44	532	29.2
80	0	0	1495	130.9
100	33×10^{-10}	3.1	739	145.6

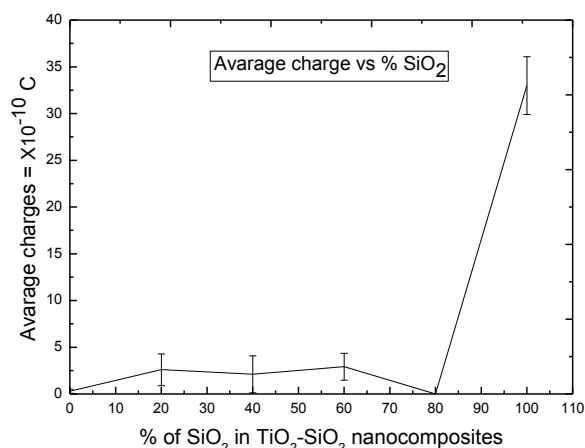


Fig. 7(i) Average charge vs % silica

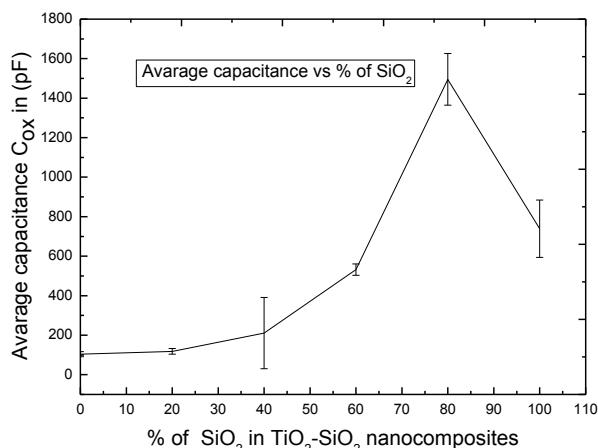


Fig. 7(ii) Average capacitance vs % silica

Result discussion (1st run)

Both of the curves (average charge vs % silica and average capacitance vs % silica), for silica-titania nanocomposites shows that when the dielectric constant decreases in nanocomposites then the average charge and capacitance increases. So, experimental result shows a contradiction behaviour with theoretical result. In this case, higher biasing voltage (-10 to 10V) has been used to performed the experiment and more or less 50% CV curves shows the breakdown voltage due to leakage current which cannot used to calculate C_{ox} , C_{fb} , ΔV_{fb} . During this experiment, maximum CV curves were observed as an anticlockwise system in double stair case. 80% silica in the nanocomposite film shown higher capacitance compare to all other nanocomposite films and it also shows that average charge is zero due to zero flat band voltage. On the other hand 100% silica observed higher charges due to higher flat band voltage.

2nd run (biasing voltage -2 to 2V)

Table 5: Sample (60%-SiO₂); Capacitance, flat band capacitance and average charge calculation

Position of sample on Hg probe	Capacitance C(pF)		Flat band voltage ΔV_{fb} (V)	Charge $\Delta Q_{ox} = C_{ox} \cdot \Delta V_{fb}$ (C)
	C_{ox}	C_{fb}		
Center	19.88	19.57	2.7	53.68×10^{-12}
Corner 1	19.84	19.53	2.0	39.68×10^{-12}
Corner 2	12.17	12.05	2.5	30.43×10^{-12}
Corner 3	12.0	11.9	2.1	25.2×10^{-12}
Corner 4	11.44	11.34	2.3	26.31×10^{-12}
Average values	15.07			35.06×10^{-12}

Table 6: Sample (80%-SiO₂); Capacitance, flat band capacitance and average charge calculation

Position of sample on Hg probe	Capacitance C(pF)		Flat band voltage ΔV_{fb} (V)	Charge $\Delta Q_{ox} = C_{ox} \cdot \Delta V_{fb}$ (C)
	C_{ox}	C_{fb}		
Center	12.43	12.31	0.8	9.94×10^{-12}
Corner 1	12.87	12.74	1.1	14.15×10^{-12}
Corner 2	12.97	12.85	1.6	20.75×10^{-12}
Corner 3	13.67	13.57	1.6	21.87×10^{-12}
Corner 4	9.26	9.19	1.5	13.89×10^{-12}
Average values	12.24			16.12×10^{-12}

Table 7: Average charges and capacitance according to composition of silica in TiO₂-SiO₂ nanocomposites (For 2nd run):

% of Silica in nanocomposites	Charge ΔQ_{ox} (C)		Capacitance C_{ox} (pF)	
	average	Std. dev.	average	Std. dev.
60	35.06×10^{-12}	10.61	15.07	4.38
80	16.12×10^{-12}	5.04	12.24	1.724

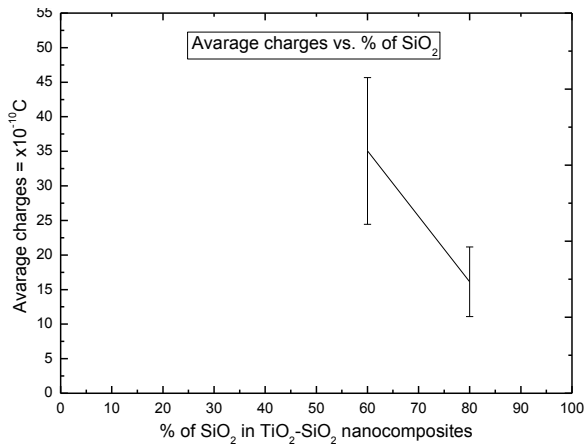


Fig. 8(i): Average charge vs. % silica

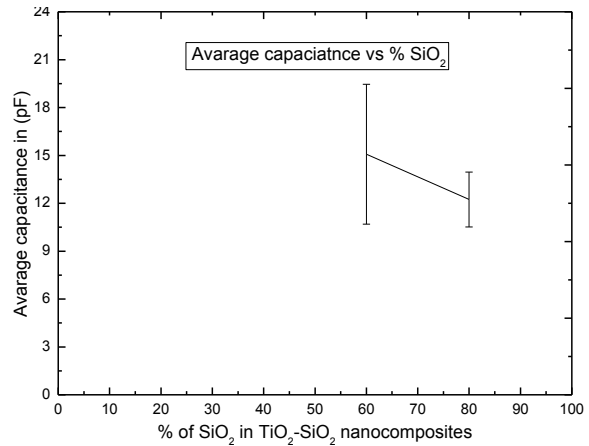


Fig. 8(ii): Average capacitance vs % Silica

Result discussion (2nd run)

Experimental results for average charge vs % silica and average capacitance vs % silica, in silica-titania nanocomposites prove that when the dielectric constant decreases then the average charge and capacitance is also decreases (fig. 8). So, the result shows an excellent similarity with the dielectric properties. During capacitance measurements from the CV curves, it has been observed that some of the CV curve shows a good homogeneity and also some other curves shows lack of homogeneity in the same sample but different observations. In this experiment low biasing voltage has been used and maximum CV curves were observed as a clockwise system in DSC, which is another contradiction with higher biasing voltage (Further study is ongoing).

Theoretical calculations: (Capacitance for the silica-titania nanocomposites);

$$C_{ox} = \frac{\xi_0 \xi_r S}{t_{ox}}$$

Where,

$$\xi_0 = 8.854 \times 10^{-12} \text{ F/m}$$

$$\xi_r (\text{nanocomposites}) = \xi_r^{SiO_2} \times P + \xi_r^{TiO_2} \times (1 - P), \quad [P = \text{Percentage of } SiO_2 \text{ or } TiO_2]$$

$$S = \pi R^2, \quad R = \Phi/2 \text{ and } \Phi = 790 \mu\text{m}$$

$$S = 3.14 \times (395 \times 10^{-6} \text{ m})^2 = 4.90 \times 10^{-7} \text{ m}^2$$

t_{ox} = thickness of nanocomposites

$$\begin{aligned} \text{Sample 60\%-SiO}_2: \quad \xi_r (60\% \text{ silica}) &= 3.82 \times 0.6 + 85 \times 0.4 \\ &= 36.29 \\ t_{ox} &= 58.34 \text{ nm} \end{aligned}$$

$$\begin{aligned} C_{ox} &= \frac{8.854 \times 10^{-12} \text{ F/m} \times 36.29 \times 4.90 \times 10^{-7} \text{ m}^2}{58.34 \times 10^{-9} \text{ m}} \\ &= 2.70 \times 10^{-9} \text{ F} \end{aligned}$$

$$\begin{aligned} \text{Sample 80\%-SiO}_2: \quad \xi_r (80\% \text{ silica}) &= 3.82 \times 0.8 + 85 \times 0.2 \\ &= 20.056 \\ t_{ox} &\approx 50 \text{ nm} \end{aligned}$$

$$\begin{aligned} C_{ox} &= \frac{8.854 \times 10^{-12} \text{ F/m} \times 20.056 \times 4.90 \times 10^{-7} \text{ m}^2}{50 \times 10^{-9} \text{ m}} \\ &= 1.74 \times 10^{-9} \text{ F} \end{aligned}$$

Table 8: Comparison between theoretical and experimental results

Sample 60%-SiO ₂ :	Sample 80%-SiO ₂ :
$C_{ox} = 2.70 \times 10^{-9} \text{ F (Theoretical)}$	$C_{ox} = 1.74 \times 10^{-9} \text{ F (Theoretical)}$
$= 5.32 \times 10^{-10} \text{ F (Experimental)} (1^{\text{st}} \text{ run})$	$= 1.50 \times 10^{-9} \text{ F (Experimental)} (1^{\text{st}} \text{ run})$
$= 1.51 \times 10^{-11} \text{ F (Experimental)} (2^{\text{nd}} \text{ run})$	$= 1.22 \times 10^{-11} \text{ F (Experimental)} (2^{\text{nd}} \text{ run})$

Result discussion

Theoretical result (capacitance) is more similar with 1st experimental result compare to 2nd run. But, the 1st run (experimental capacitance) results are not alike with the dielectric properties according to % of silica and titania in TiO₂-SiO₂ nanocomposite films. Where the 2nd run (experimental capacitance) results shows a good similarity with the dielectric properties of silica and titania composition in TiO₂-SiO₂ nanocomposite films.

VI. Conclusions

During the experiment of CV curve measurement for MOS capacitor in DSC, two types of biasing voltage has been used. Where frequency (100 kHz) was fixed in both of the cases. First run of the experiment has been used high biasing voltages (e.g., -10 to 10V) and obtained high capacitance, but problem is that the experimental capacitances suggest the inverse composition of silica in the $\text{TiO}_2\text{-SiO}_2$ nanocomposite films (fig. 7). That means the experimental result (capacitance) has no resemblance with the dielectric properties of nanocomposites composition. But when the experiment has performed at low biasing voltage (e.g., -2 to 2V) then the experimental capacitance shows same trend with dielectric properties of the $\text{TiO}_2\text{-SiO}_2$ nanocomposite composition according to silica and titania (fig. 8). Both of the cases (Low and high biasing voltages) during CV curves measurement, experiment shows some breakdown voltage due to leakage current. But maximum breakdown occurred during the first run of the experiment and this is due to the higher biasing voltage and may be this is the reason that the experimental MOS capacitance did not shows the similarity with the dielectric properties according to the composition of silica/titania in silica-titania nanocomposites. 40% and 60% silica in the $\text{TiO}_2\text{-SiO}_2$ nanocomposites shown a excellent natural super hydrophilic properties. Our experimental result (electrical characteristics) also suggest a good correlation with this property, e.g., during CV curves measurement this two types of sample (40% and 60% silica) in the nanocomposite shows a less breakdown voltage compare to another composition in the nanocomposite films. All of the characterisation (physical and electrical) noted that 60% silica in nanocomposites is a good candidate in MOS capacitor. Only for electrical characterisation the experiment further can continue, for new sample and using different biasing voltages to reveal the contradictory results between capacitance and the dielectric properties according to the composition of SiO_2 and TiO_2 in $\text{SiO}_2\text{-TiO}_2$ nanocomposites.

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