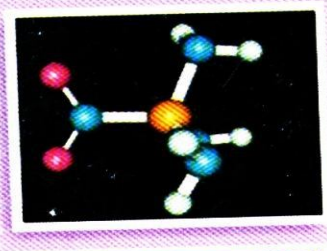
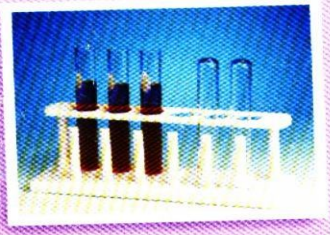




"THE CHEMICAL PATHWAY: SMALL CHANGES THAT MADE A DIFFERENCE"

23rd Inaugural Lecture

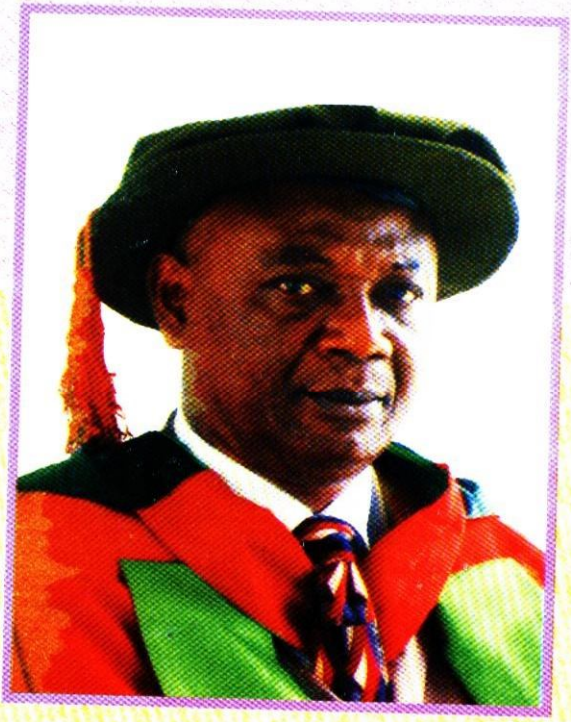
of the Federal University of Technology, Owerri (FUTO), Imo State.

Delivered on
Wednesday, 27th March, 2013

By **PROFESSOR GODDY NKEM ONUOHA**

Ph.D, CChem, FICCON, FCSN, MIPAN, JP
Professor of Chemistry,
Department of Chemistry, School of Science
Federal University of Technology, Owerri (FUTO)
Imo State, Nigeria.

23rd INAUGURAL LECTURER



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PROTOCOL

Mr. Chairman Sir, I salute you and your management team, for the opportunity of this inaugural lecture. My salute also goes to the Chairman and members of the University Lecture series for their efforts and sacrifices to have this lecture hold today.

I recall my first official invitation to attend and listen to an inaugural lecture. That was when I was a Graduate Assistant at the University of Ibadan. It was always an honour to be invited to the Trenchard Hall. And every inaugural lecturer felt on top of the world.

For me today, this Celestine Onwuliri International Conference Centre here in FUTO, epitomises the Trenchard Hall in fame and importance. And I owe it to you all that I stand here today, as the masquerade.

Having mentioned the name of Professor Celestine O. E. Onwuliri, let me quickly seize the opportunity to express my heart-felt condolences to the entire nation, the Federal University of Technology, Owerri in particular and to the family of Prof. COE Onwuliri for his demise.

I was already away on leave of absence when he was appointed as the 5th substantive Vice-Chancellor of this great University. And I was still away when he concluded his term of office. But I am a living witness that Prof. Onwuliri touched positively on lives, including the lives of people who were away, like my humble self.

Prof. COE Onwuliri was an enigma, visibly appreciated, deeply loved and generally respected. But God sure loved him more.

In stepping forward today, I must say that I yearn to fulfil an academic obligation. I have not promised a good lecture. But I promise to do my best. And so, to all who will find the lecture either

boring or uninteresting or both, I offer my unreserved apologies afore hand and ask for your forgiveness.

The new WAGmob App for Chemistry, Organic Chemistry and Biochemistry available in the Apple internet store defines Chemistry as:

What happened during your breath? Look at the chemical equation for respiration:

$$O_2 + 4e^- + 4H^+ \longrightarrow 2H_2O.$$

During the breath, you took in oxygen and that oxygen got reduced to water by electrons and protons. This is the equation of life. It has remained one of the world's most important reactions and we must appreciate that in giving man life, God balanced this chemical equation and has ever since, sustained it.

When the food we eat gets involved, this equation of respiration expands into:

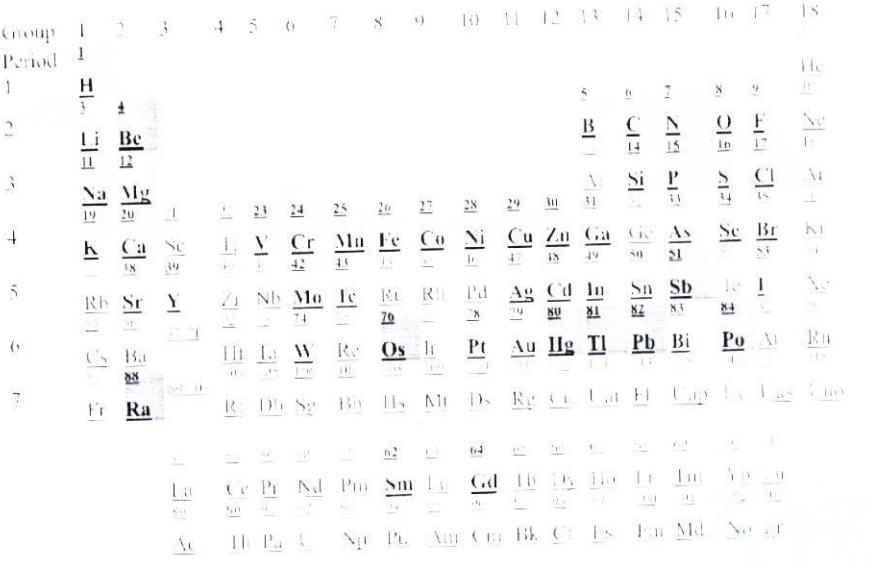
$$C_6H_{12}O_6 + 6O_2 \underset{\text{photosynthesis}}{\overset{\text{respiration}}{\rightleftharpoons}} 6CO_2 + 6H_2O$$

Question : **"Who is the first Chemist"?**

Even the Periodic Table of elements is arranged by nature in an amazing manner. Let us just take a look at how life is affected by the elements of the periodic table. We can quickly identify 5 broad groups:

Periodic Table and Life

ELEMENTS OF BIOLOGICAL RELEVANCE



BULK BIOLOGICAL ELEMENTS.

ESSENTIAL FOR A WIDE RANGE OF BACTERIA, PLANTS AND/OR ANIMALS.

ESSENTIAL OR POSSIBLY ESSENTIAL FOR SOME SPECIES.

USED IN MEDICINE OR DIAGNOSTICS.

POISONOUS, DEPENDING ON DOSAGE.

(a) The bulk biological elements: includes metals and non-metals

(b) Essential for a wide range of bacteria, plants and or animals: mostly in the first row of the transition elements and also includes some non-metals

(c) Essential or possibly essential for some species, like bacteria in ocean beds.

(d) Used in medicine or diagnostics and not necessarily naturally occurring. The elements here show a variety of properties and scientists are playing around such properties and the list of their use is growing. Platinum, for example is becoming important in cancer research

(e) Poisonous, depending on dose. This list is not exhaustive and the level of toxicity of some other elements is being determined.

We can attempt to summarize the biological roles of the elements:

- Charge Balance and electrolytic conductivity: Na, K, Cl
- Structure and Templating: Ca, Zn, Si
- Signalling: Ca, No, Zn etc
  Regulating signals in cells and in between cells.
- Bronsted Acid-Base Buffering: P, Si, C
- Lewis Acid-Base Catalysis: Zn, Fe, Ni, Mn, Mg
- Electron Transfer: Fe, Cu, Mo
  Where do the electrons that are used in respiration to release energy come from?
- Group Transfer (eg O, CH_3, S): V, Fe, Co, Ni, Cu, Mo, W.
  What facilitates the transfer of oxygen in the lungs?
- Redox Catalysis: V, Mn, Fe, Co, Ni, Cu, Ni, W, Se, S.
- Energy Storage: H, P, S, Na, K, Fe

How do you store energy in the cells and how do you release energy for chemical reactions in the body?

- Biomineralization: Ca, Mg, Fe, Si, Sr, Cu, P
  When you take a look at the shell of a mollusc, for instance, do you wonder how and where the structure resulted from?

Question: What on earth is not Chemistry?

From the point of exit from the Garden of Eden, man's need for food, shelter, good health, among others, has continued to drive him to innovate, create value and take advantage of natural resources. It goes without saying that mother-nature, with divine wisdom, makes the practice of Chemistry an imperative.

The first humans that got hold of cassava tubers and ate them just like any other tuber died in their numbers as a result of cyanide poisoning of the Cytochrome system. One option was to abandon cassava as food. But hunger will not go away un-attended. It was man's relentless sense of methods that led him through various process technologies, until chemical hydrolysis of cassava was achieved through intuitive science.

Cooking is essentially a series of chemical reactions. It is helpful therefore to know some basics. As an example, putting vegetables into boiling soup causes the cells of the vegetables to pop, resulting to a brighter and appetizing green. However, longer cooking causes the plant's cell wall to shrink and release an acid that turns the vegetable an unappetizing shade of grey.

What nature offers is petroleum crude. But your automobile runs on PMS (premium motor spirit), the prime movers run mostly on AGO (automotive gas oil), the jets run on aviation kerosene, DPK (dual purpose kerosene), your domestic cooking is dependent on methane gas, etc. The petroleum crude must therefore undergo value addition processes and that is why the refineries have come to stay.

Chemical compounds provide the foundations for;

*Medicine
*Biochemistry
*Biotechnology.

Chemistry is, in the main, the subject in industries like

*Rubber
*Plastic
*Food
*Pharmaceutical
*Detergent
*Coatings
*Dyestuffs and
*Agrochemicals.

The list is unending and the conclusion is that the challenge for the Chemist is to use what is available, to get what is needed. This appears to suggest, in line with the definition of the Dictionary.com & Thesaurus, that the Chemist must be a magician. And why not?

Despite being as old as creation, Chemistry is still one of the fastest growing arms of Science. This is attested to by the fact that nearly a thousand new compounds are discovered each day.

As a growing boy, I attended a Sunday school class during which a teacher told a bible story that has kept me fascinated till today. He took his text from among the synoptic gospels, precisely the gospel according to John, Chapter 2, verse 5. The theme of his lesson

"Whatsoever He saith unto you, do it'.

It will be the subject of a good debate to decide who takes the credit for the miracle in Cana: Mother or Son?

What happened has not been, and may never be, comprehended by man. Being divine, He was capable of providing the wine out of nothing. But He chose to add value to one of nature's commonest commodities- water. The testimony was given by the Master of the Banquet when he mildly rebuked the bridegroom in these words "Everyone brings out the choice wine first and then the cheaper wine after the guests have had too much to drink, but you have saved the best till now".

Just out of curiosity, we may attempt to ponder what happened in the context of present day developments, that is, after more than two thousand years of Research and Development activities.

$$H_2O \dashrightarrow C_2H_5OH$$

My fascination for what happened made me to fantasize. With my little chemistry as I grew, I applied the law of conservation of mass innocently and got:

C_2H_5OH = 2Carbon atoms, 6 Hydrogen atoms and 1 Oxygen atom, while

H_2O = 0 Carbon atom, 2 Hydrogen atoms and 1 Oxygen atom

Therefore,

$C_2H_5OH - H_2O$ = 2 Carbon atoms and 4 Hydrogen atoms.

The simplest compound 2 carbons and 4 hydrogens will give is ethylene, C_2H_4

Hence, I postulated that

$$C_2H_4 + H_2O \rightleftharpoons C_2H_5OH$$

Even as I grew in Chemistry, I continued to fantasize this reaction. Suffice to say that I did not achieve it. But I was always encouraged and challenged by His words as recorded in the gospel of Luke, Chapter 17, verse, 6:

> "If you have faith as small as a mustard seed, you can say to this mulberry tree, 'Be uprooted and planted in the sea,' and it will obey you".

I smiled broadly to myself, the day I read from Literature [1] that one of the synthetic methods of producing ethanol was by hydration of ethylene.

$$CH_2 = CH_2 + H_2O \xrightarrow{H_2SO_4} CH_3CH_2OH$$

So my fantasy did not fail me entirely. What I didn't know was that sulphuric acid was needed as catalyst. And that was before I became acquainted with the subject of catalysis.

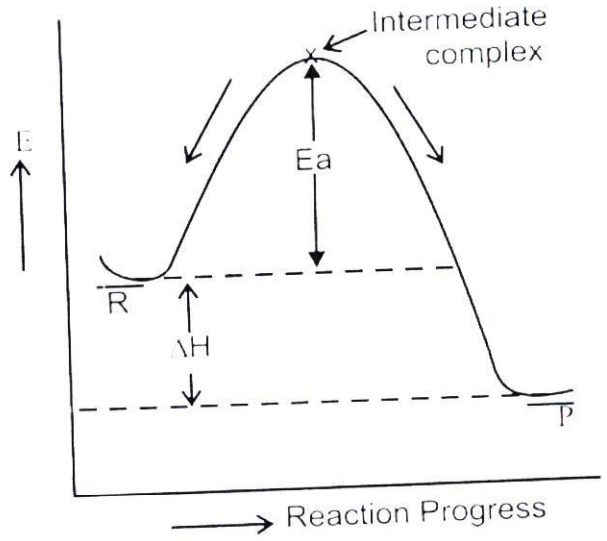
MY RESEARCH INTEREST

My research interest is in reaction mechanisms generally (the Chemical Pathway) but more specifically, the mechanism of reactions in solution, with bias for nucleophilic substitutions in aromatic systems (S_NAr), where we have been consolidating on the gains of the Linear Free Energy Relationship (LFER) approach (Small Change) we developed for the elucidation of the mechanism of this class of reactions in non-polar media.

During chemical reactivity, reactant molecules collide with one another. For a reaction to occur, the collision energy must be greater than the activation energy.

The transition state theory focuses on intermediate species which result from the collision of reactants during chemical reactions.

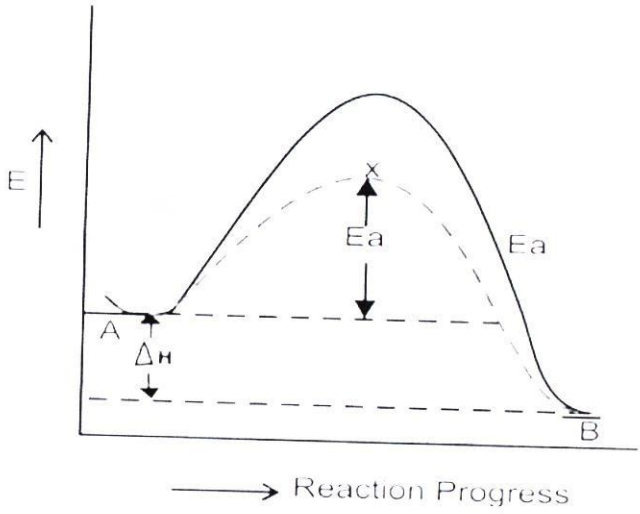
These species exist transiently and dissociate either back to reactants or progress to give products.



A number of factors affect the rate of chemical reactions. These include concentration, temperature, pressure when gases are involved and the presence of catalysts or inhibitors, which themselves are not consumed. While catalysts cause the rate of reactions to increase, inhibitors do the reverse.

Catalysis.

A catalyst speeds up the rate of a reaction by reducing the energy of activation, Ea. This reduction of activation barrier favours both the forward and backward reactions.



Reaction Mechanism.

Reaction mechanism shows the relationship between the reaction pathway and the rate law. It is a series of elementary steps that must satisfy three irrefrangible rules. These are:

1. The sum of the elementary steps must give the overall balanced equation for the reaction.
2. The mechanism must agree with the experimentally determined rate law
3. The slowest step is the rate determining step, RDS.

The work presented in the first part of this lecture is in the area of nucleophilic aromatic substitution.

Rationale/Justification

The impetus for the study of this class of Aromatic Nucleophilic Substitution (ANS) is provided by the synthetic potentials they offer [2]. Also, they provide models for the study of the transmission of electronic effects in aromatic systems as well as for the study and

elucidation of the mechanisms of base catalysis in multi-step reactions.

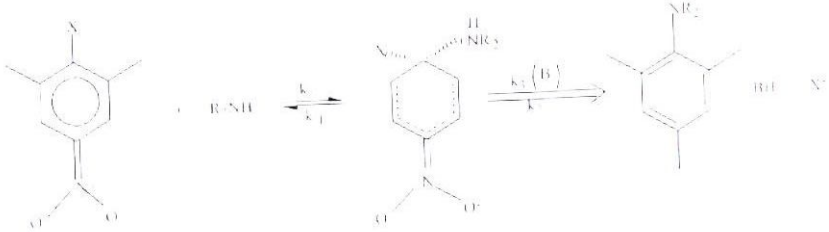
Problem

The mechanism of the Aromatic Nucleophilic Substitutions in non-polar aprotic solvents was for a long time, the subject of criticism and modification by several groups of researchers. While some workers proposed the cyclic transition state [3], others favoured the specific base, general acid, SB-GA [4, 5, 6]. It did appear that a single set of data could lend itself to different mechanistic interpretations. The resulting confusion made it imperative that an attempt be made to provide a unified theory of mechanism for S_NAr reactions in this class of solvents.

Aromatic Substitution Reactions.

In an aromatic substitution reaction, a bond with the aromatic carbon is broken and a new one is formed. A reaction is formally designated nucleophilic, free-radical or electrophilic depending on how many of the two electrons needed to form the new bond is furnished by the reagent. If the reagent furnishes both electrons, the reaction is termed nucleophilic. It is electrophilic when none of the electrons is provided by the reagent, while for a radical reaction, the reagent furnishes only one electron to the new bond.

When primary or secondary amines are the nucleophiles in these reactions, the intermediate complex, IC, mechanism can be represented as in scheme 1.



SCHEME 1

The first formed intermediate I is zwitterionic in nature and its decomposition to product could be by either of two pathways:

(a) It could go directly to products through an uncatalysed path involving the rate coefficient k_2 or

(b) Through a catalysed pathway in which the catalyst is either another molecule of the nucleophile or an added base and involves the rate coefficient, k_3.

If the steady-state (Bodenstein) hypothesis [7] is applied to Scheme 1, then the observed second-order rate constant, k_A, is given by equation 1.

$$k_A = \frac{k_1(k_2 + k_3[B])}{k_{-1} + k_2 + k_3[B]} \quad \text{..... 1}$$

Three possible kinetic forms are observable, depending on the relative magnitudes of k_{-1} and $k_2 + k_3[B]$.

(a) When $k_{-1} \gg k_2 + k_3[B]$, equation (2) results from equation (1) thus;

$$k_A = \frac{k_1(k_2)}{k_{-1}} + \frac{k_1 k_3[B]}{k_{-1}} \quad \text{..... 2}$$

Here we observe a linear dependence of k_A on base concentration, decomposition of the intermediate to products being rate-limiting and the reaction is susceptible to base catalysis.

(b) When $k_{-1} \ll k_2 + k_3[B]$, equation reduces to equation (3), and the formation of the intermediate, **I**, constitutes the rate-limiting step. This kinetic condition results in the reaction being insensitive to base catalysis.

$$k_A = k_1 \quad \text{..... 3}$$

(c) A third condition arises when values of k_{-1} and $k_2 + k_3[B]$ are comparable in magnitude. A curvilinear dependence of k_A on base concentration is obtained. At low base concentration, the dependence of k_A is linear and the decomposition of the intermediate to product is rate-limiting. This linearity changes to a plateau at high base concentration in which case, the formation of the intermediate becomes rate-limiting and the system is rendered insensitive to base catalysis.

Evidence abound in literature that these three distinct classes of kinetic conditions occur [8, 9, 10].

The system employed in this investigation is the reaction of morpholine, a secondary amine, and 1-Fluoro-2, 4- dinitrobenzene and 1-chloro-2, 4-dinitrobenzene as substrates. The medium was benzene, a typical non-polar aprotic solvent.

The pipette technique was adopted to monitor the kinetics of all reactions and it involved, first preparing the product, N-[2, 4-dinitrophenylmorpholine] by standard methods, scanning dilute solutions of it to determine the wavelength of maximum absorption, λ_{max}. For this product, the λ_{max} was determined to be 370nm. The extinction coefficient was determined by application of the Beer's Law in the quenching mixture, which was 1M sulphuric acid in methanol. All kinetic runs were performed with the nucleophile concentration, ten-fold higher than that of the substrate to ensure first-order kinetics.

It is instructive at this juncture, to examine the theory behind this work and its experiments. Taft and Gurka [11] reported definitive hydrogen-bonded parameters for 62 bases of widely different

structures at 25°C, using para-fluorophenol and carbon tetrachloride, (a typical non-polar aprotic solvent). In their work, they evaluated the formation constant, K_f, for the formation of 1:1 hydrogen-bonded complexes in an equilibrium of the type in equation 4.

$$P\text{–}FPhOH + B \rightleftharpoons P\text{-}FPhOH\cdots B \quad \ldots\ldots 4$$

In another report [12], Taft examined the generality of the effects of base structure on log K_f values and found a generalised linear free energy relationship (LFER) of a satisfactory level of precision. This linear free energy relationship was expressed in the form of equation (5), where K_f is the formation constant of hydrogen-bonded complexes and the constants m and C are characteristics of the proton-donor, the solvent and temperature.

$$\text{Log } K_f = mpk_{HB} + C \quad \ldots\ldots 5$$

According to these workers, increased values of m and C denote increased stability and therefore decreased standard free energy of the hydrogen- bonded complex.

The pk_{HB} is therefore a unique base parameter that measures the strength of the acceptor in hydrogen-bond complex formation. While K_f, m and C for a given acid-base complex bear an inverse relationship with solvent polarity, log K_f is a measure of the ability of bases to form hydrogen-bonded complexes.

Our laboratories, in an earnest effort to evolve a unified theory of mechanism for nucleophilic aromatic substitutions, S_NAr, in non-polar aprotic solvents, recognised the possibility that such hydrogen- bonded complexes, which are homo- and hetero-conjugates in the real sense, could be responsible for the catalysis of

bimolecular nucleophilic aromatic substitutions in non-polar aprotic media.

We postulated and therefore incorporated the pk_{IIB} as a parameter into the rate equation and thereafter designed experiments that could prove the involvement or otherwise of such aggregates.

If we depict the nucleophile as N and the catalyst as P, then the equilibrium of equations (6) and (7) result, where (6) is the step for the reversible deprotonation of the first-formed intermediate, **I.**

$$I + N \rightleftharpoons NH^{+} + II \qquad \text{..... 6}$$

Then,

$$NH^{+} + P \rightleftharpoons \left[N\text{----}H\text{----}P\right]^{+} \qquad \text{..... 7}$$

Hetero-conjugate.

If the hetero-conjugate catalyses the departure of the leaving group moiety, then equation (8) applies.

$$II + \left[N\text{----}H\text{---}P\right]^{+} \xrightarrow{\text{slow}} \text{Products} \qquad \text{..... 8}$$

The rate equation is thus given by equation (9):

$$\frac{d(products)}{dt} = k_3''[II]\ [N \ldots H \ldots P]^{+} \qquad \text{..... 9}$$

From equation (6),

$$K = \frac{[NH^{+}]\ [II]}{[I]\ [N]} \qquad \text{..... 10}$$

From equation (7),

$$K_f = \frac{[N...H...P]^+}{[NH]^+[P]} \quad \text{..... 11}$$

Incorporating expressions for [II] and [N..H..P]$^+$ from equations (10) and (11) respectively into equation (9) gives equation (12).

$$\frac{d(product)}{dt} = k''_3 K K_f [I][N][P] \quad \text{..... 12}$$

When this is inserted into the steady state (Bodenstein) equation for the catalysed reaction, ie our equation (2), what results is equation (13).

$$k_A = \frac{k_1(k_2 + k_3[N])}{k_{-1}} + \frac{k_1 k''_3 K K_f [I][N][P]}{k_{-1}} \quad \text{..... 13}$$

If the kinetic runs are done at constant nucleophile concentration, [N], but varying catalyst concentrations, [P], then plots of k_A against [P] will be linear, with slope equal to the expression of equation (14).

$$Slope = \frac{k_1 k''_3 K K_f [I][N]}{k_{-1}} \quad \text{..... 14}$$

If we substitute the expression for log K_f in equation 5, we obtain equation (15).

$$\log slope = log \frac{k_1 k''_3 K[I][N]}{k_{-1}} + mpk_{HB} + C \quad \text{..... 15}$$

If the position of our postulate is valid and the Taft-Kamlet free energy relationship holds for our system, then a plot of log slope against pk_{HB} should give a straight line with slope equal to m.

Table 1 shows the values of k_3/k_2 ratio pk_{HB}, slope parameter for the reactions in the presence of various catalysts and other relevant physical constants from the literature.

TABLE 1 - Values of pk_{HB}, pk_a in water and DEC[a] for additives to the reaction of I-fluoro-2, 4-dinitrobenzene with morpholine in benzene at 30°C and values of the k_3/k_2 ratio and slope parameters for reactions in the presence of various additives.

Catalyst	$Pk_a(H_2O)$	pk_{HB}	DEC[a]	slope	Log slope	k_3/k_2
Morpholine	8.42	~2.00	7.42	4.33	0.64	482.4
Pyridine	5.25	1.88	12.41	0.73[i]	-0.14	C/U
DABCO	8.60	2.21		3.86	0.58	225.10
DMSO	1.40[f]	2.53	46.68	4.80	0.68	287.80
PNO	0.79	2.76		6.88	0.84	344.70
HMPA		3.56	30[d]	26.30	1.42	1294.10
MeCN	-10.12[c]	1.05	37.50[d]	0.03	-1.53	1.44
CHA	-6.80[e]	1.30	18.30	0.08	-1.09	3.62
Anisole	-6.54[e]	0.02	4.33			
N,N-DMA	5.07					
THF	-2.08[e]	1.26	7.58			
4-PIC	6.03	2.03		1.07	0.03	75.70
Et_3N	1072	1.91	2.42	0.65	-0.65	C/D
TPPO		3.6				
$PhNO_2$		0.73	34.82	0.11	-0.97	5.42

Three distinct kinetic forms are recognised from the results, viz (i) those that did not catalyse the reaction. This was the case with methyl cyanide, MeCN, Cyclohexanone, CHA, Anisole, N, N-Dimethylaniline, Tetrahydofuran, THF and Triphenyl Phosphine Oxide, TPPO.

(ii) the second form include Morpholine, the nucleophile, 1, 4-diazabicyclo(2, 2, 2) Octane, DABCO, Dimethyl Sulphoxide, DMSO, Pyridine-N-Oxide, PNO and Hexamethylphosphoramide, HMPA.

(iii) the third kinetic form was exhibited by Triethylamine, Et_3N and Pyridine, Py, which showed curvilinear dependence of k_A on catalyst concentration. While Triethylamine showed curvilinear (downwards) dependence, Pyridine showed a curvilinear (upwards) dependence.

The first form clearly depicts insensitivity to catalyst concentration and therefore proceeded via the uncatalysed path, involving the rate coefficient, k_2. Here, the formation of the intermediate is rate-limiting.

The third form showed a non-linear dependence of rate on catalyst concentration. In the case of pyridine that exhibited curvilinear upwards dependence, a plot of k_A against the square of catalyst concentration, gave a linear result, confirming quadratic dependence of the rate on the catalyst concentration. This showed that this catalyst participated via dimers of the amine.

The second kinetic form is of immense interest to this work. Each catalyst showed linear response to increasing additive concentration and the values of their k_3/k_2 ratio are typically ≥ 50 l mol^{-1}, the threshold for indicating genuine and strong catalysis [13].

This class is an interesting mixture, being made up of two bases, an N-Oxide, a sulphoxide and a phosphoramide. Catalysis by this group is not explicable in the formal Bronsted-Lowry sense, since the

magnitude of catalysis shown by their k_3/k_2 values is completely independent of base strength. The observed order of catalytic effectiveness of HMPA, PNO, DMSO, DABCO, 4-Picoline cannot be explained in terms of acid-base catalysis.

As mentioned earlier, it is possible that homo- and hetero-conjugates intervene in the mechanism of these reactions. These equilibria actually describe the formation of hydrogen-bonded complexes in non-polar media. If this was the dominant effect of these additives, then it should be possible to correlate the magnitude of catalysis with the hydrogen-bonding ability of these additives. The qualitative measure of this parameter is provided by the pk_{HB} values, obtained from the Taft-Kamlet linear solvation free energy relationship [12] and included in Table 1. Such a correlation, involves a plot of log slope (derived from plots of k_A versus catalyst concentration) against pk_{HB} values.

The relevant plot is shown in Figure 1. It is indeed linear, with a correlation coefficient of 0.89, indicating that the linear free energy relationship of equation 15 is obeyed for the reaction catalysed by this group of catalysts.

When the point for Morpholine, the nucleophile is excluded in the plot as seen in Figure 2, the correlation coefficient improves to 0.985.

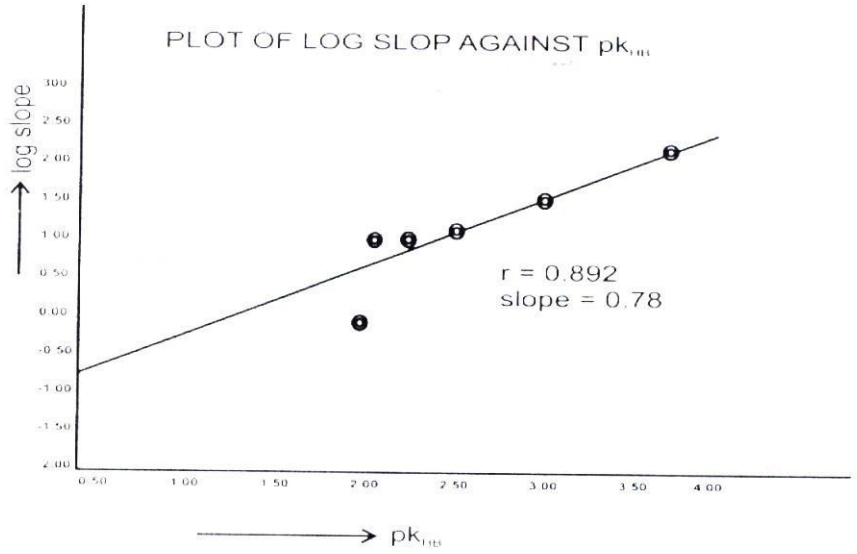


FIGURE 1

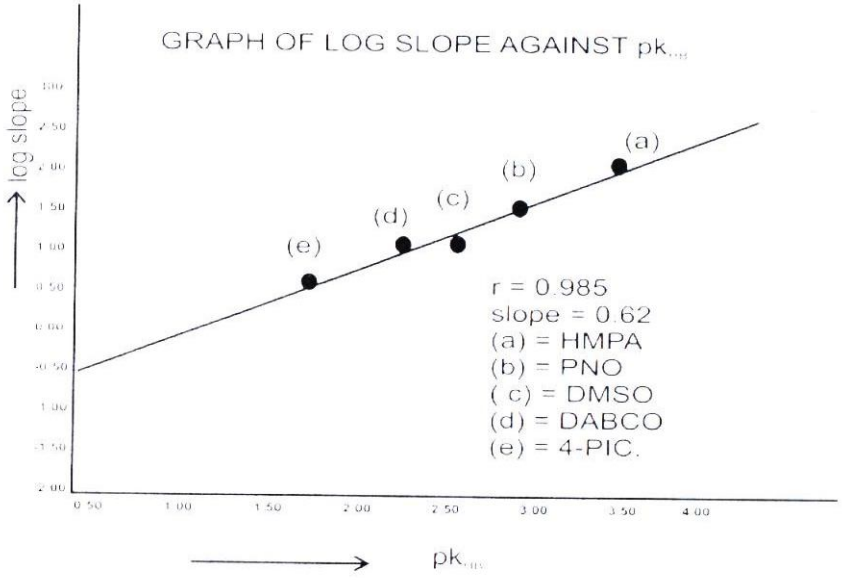
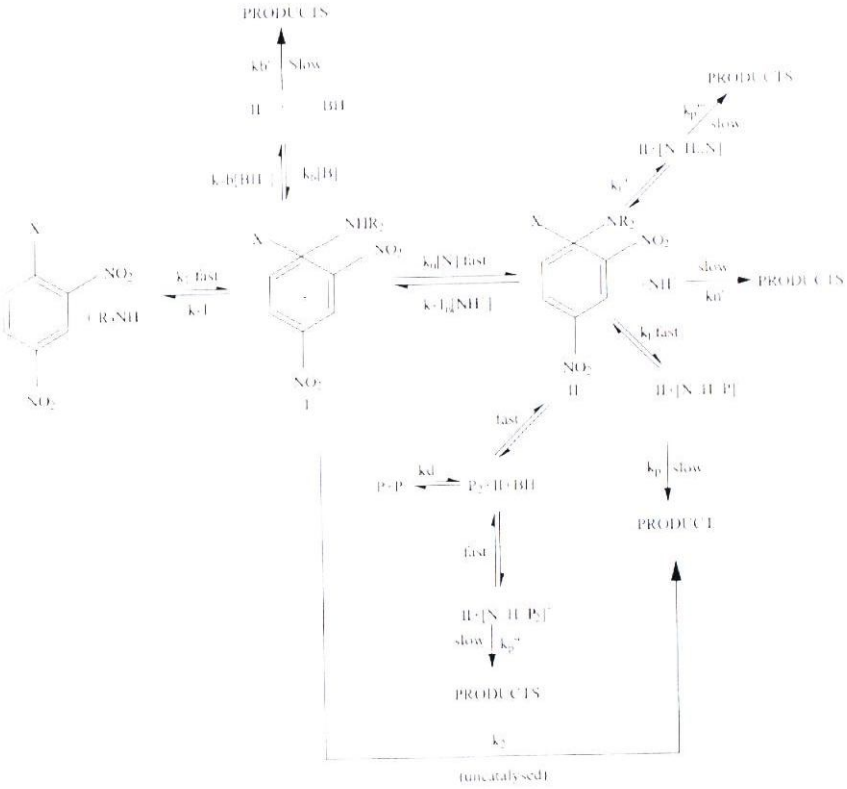


FIGURE 2

With these conclusions, and sure as we are that our scheme is consistent with the earlier mentioned irrefrangible rules, we made bold and went to press [14-17], putting forward a comprehensive mechanism for Aromatic Nucleophilic Substitution (ANS) in non-polar aprotic media. Our mechanism is shown in Scheme 2 and takes care of all aggregation phenomena of homo- and hetero-conjugation as well as the possible dimerization of certain catalysing species, like pyridine, prior to the expulsion of the leaving group moiety.



SCHEME 2

Corrosion

We also did some work on Corrosion control and Corrosion inhibition.

Corrosion refers to the consumption of metal as they are exposed to their working environment or surrounding. It is a spontaneous redox reaction in which a metal is attacked by some substances in its environment and converted to an unwanted compound.

For nearly all metals, oxidation is thermodynamically favourable in air at room temperature. When the oxidation of a metal is not inhibited, it can destroy the object. This has huge economic impact on industries in particular and productivity in general. It has been reported that about 20% of the iron produced annually in the United States is used to replace iron objects that have been discarded because of rust.

Not too long ago, the canopy of the dome of Maria Assumpta Cathedral in Owerri was replaced, no doubt, at a huge cost. Exposure, over time, must have impaired with the functioning of the original metal roofing members.

The need to research into ways of preventing or inhibiting Corrosion of metals cannot be over emphasized.

We worked on the inhibition of Corrosion of aluminium and made modest contributions on the prevention of Corrosion of this metal, both in acidic [18] and alkaline [19] media, using various indicator dyes. We did some work too, on Corrosion control of mild steel [20, 21]. We also did show [22] that extracts of *Gongronema latifolium*, is an environmentally friendly Corrosion inhibitor for aluminium, even in strongly acidic and alkaline environment.

BIO-FUELS.

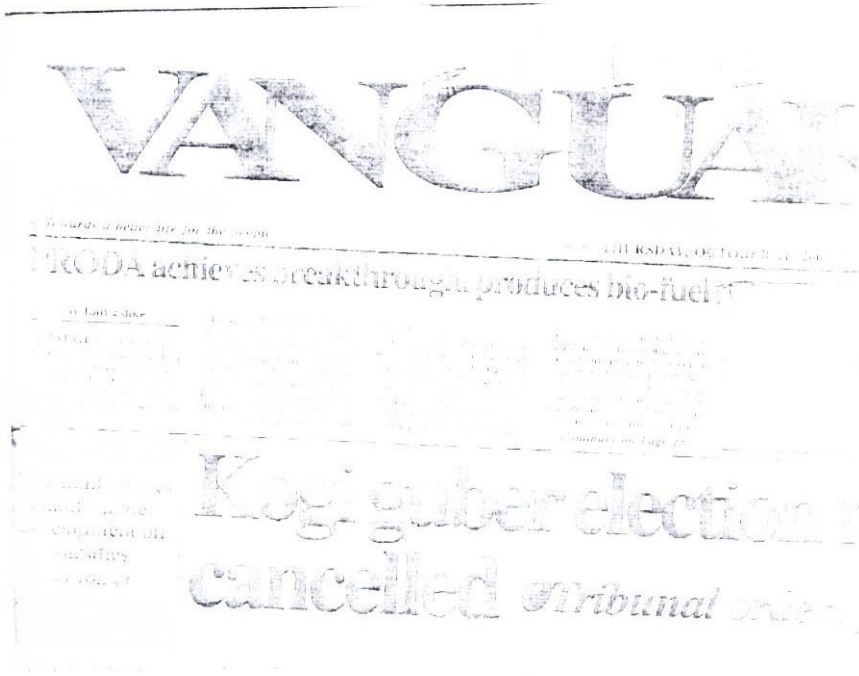
PRODA had developed an alcohol plant for commercial production

of industrial ethanol. It consisted of stripping/rectifying towers working on the same principle as the petroleum refineries and was conceived, following numerous inquiries from local distillers of illicit gin that wished to produce non-illicit gin. The plant ran on its own steam boilers and centralized control panel.

The product which was about 95% ethanol, found uses in the Chemical, Pharmaceutical and cosmetic industries. It was also useful to Science laboratories and allied solvent users.

Research continued on this plant with a view to improving on the yield and percentage alcohol. The resultant azeotrope formed between water and ethanol at about 95% alcohol gave us cause to try other non-physical processes.

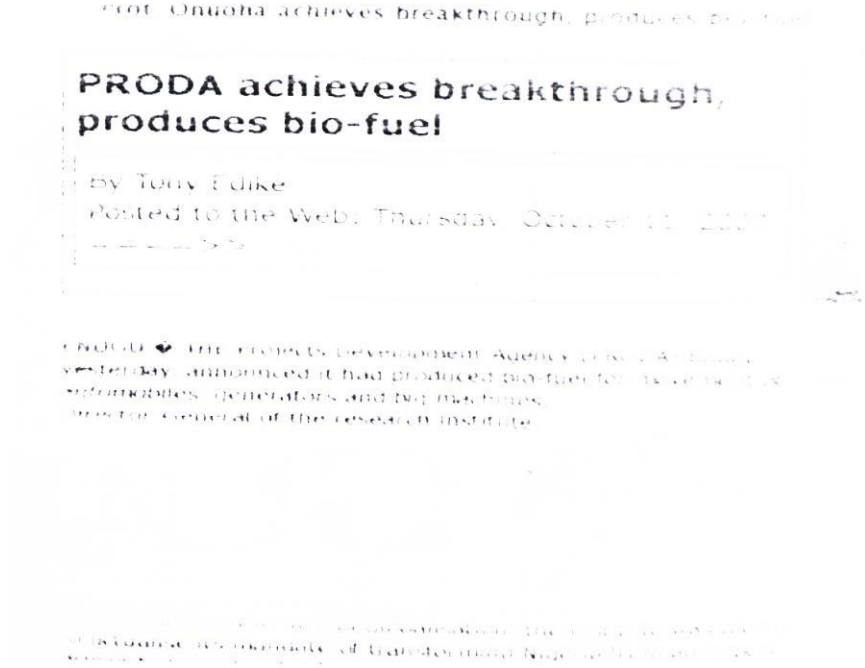
We succeeded in producing biofuels.


VANGUA

THURSDAY, OCTOBER 11, 20

PRODA achieves breakthrough, produces bio-fuel

Kogi guber election cancelled Tribunal



Prof. Onuoha achieves breakthrough, produces bio-fuel

PRODA achieves breakthrough, produces bio-fuel

By Tony Edike
Posted to the Web: Thursday, October 11, 2007

ABUJA ❖ The Projects Development Agency (PRODA) yesterday announced it had produced bio-fuel for [illegible] automobiles, generators and big machines.
Director General of the research institute

We received a grant of $0.5m from the World Bank assisted Science and Technology Education, Post-Basic (STEP-B), to research into the Conversion of Waste Biomass to Biofuels.
The Projects Development Objectives, PDOs, were made clear by the World Bank and these included:

- To improve indigenous research execution capacity in Science and Technology for the purpose of resolution of National Problems

- To improve human capacity building in Science Education at Post Graduate, Undergraduate and Technologists level of education
- To produce Science Technology professionals capable of standing besides their peers in a global context.
- To foster and promote linkage relationships with other Research Institutes, Universities, Governments at all levels, Enterprises for the purpose of innovative Science.

The PRODA step-B painstakingly followed the stipulated guidelines and focussed in the main, on the development of the critical manpower needed to tackle national problems. The project team developed a bio-reactor [23] that has been optimally utilized in the pursuit of the objective of that project.

Under the Project, we produced four Ph. Ds and four Masters Degrees. These include:

(1) Jude C. Obubuzor (NIFOR Benin) : Ph. D., 2009
Palm Fibre Utilization for the Production of Bioethanol.

(2) Richard C. Ehiri (Ebonyi state University) Ph. D.,2009
Factor interaction during optimization of Catalysts for biodiesel Production.

(3) Charles Nkem Agulanna, (PRODA, Enugu) Ph. D. 2012
Development of Integrated System of Bioreactors for Anaerobic Digestion of Organic Waste.

(4) Ali Bilar (Federal Polytechnic, Nekede), Ph.D. 2012
Factor Analysis of Anaerobic degradation of Organic Components of Municipal Wastes.

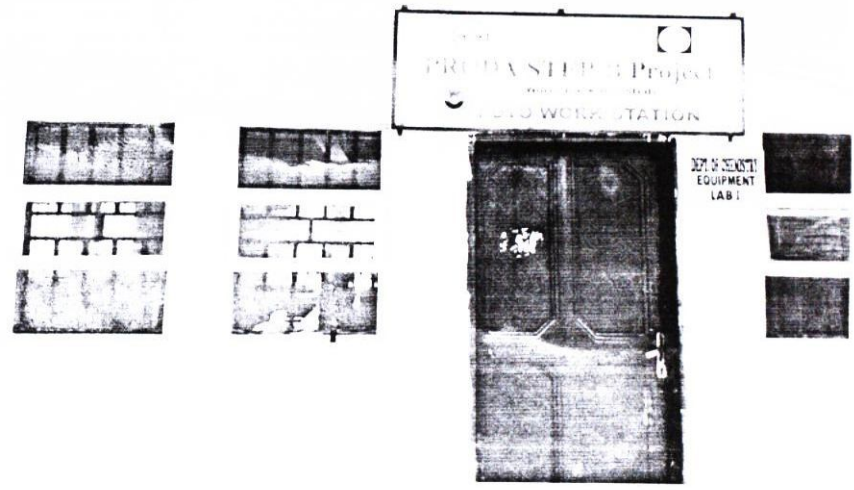
(5) Nkechi Blessing Anyile(Renaissance University, Enugu), M.Sc. 2008
Optimization of Biodiesel Production using Program Catalysis Regime

(6) Eberechi Asiegbu, M. Sc. 2010
Factor Interaction in Acid Catalysed Optimization of Biodiesel Production

(7) Onwuka Obasi Kalu, M.Sc. 2010
Optimization of Acid Pre-treatment Procedure for Oil Palm Fibres Bioethanol Production

(8) Nkechi Nwagbara (PRODA, Enugu) M. Sc. (awaiting defence)
Effect of $_{p}H$ on Pressure Explosion Pretreatment of Palm Oil Fibres.

On linkages and collaboration, I did not have to look too far. East, West, North or South, home is the best. I had to create the PRODA STEP-B Project FUTO Work Station.

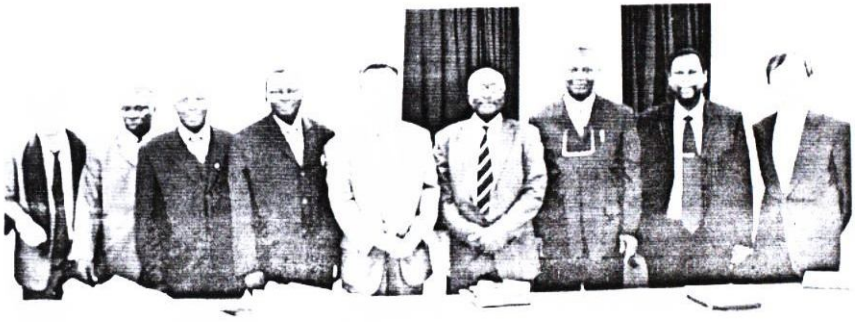


In terms of equipment, the University work station can boast of

- a Buck Scientific Gas-Liquid Chromatographic equipment, GLC, with three detectors,
- a Reaction Centre able to control reactions between -10 and 250°C

- A pressurized Gas reaction System
- An all glass distillation set, capable of delivering 10 litres an hour
- Good stock of glass-wares and other consumables.

On capacity building, we trained staff in the facilities of the Original Equipment Manufacturers, OEM. To this end, PRODA staff, including my humble self, and Prof. Emma Ejike of FUTO were trained in Cambridge, at the facility of Cecil Instruments, in Moline, Chicago at the facility of Parr Instruments and in Connecticut at the facility of Buck Scientific Instruments.



A delegation from Nigeria visited the Japan National Institute for Materials Science and met with the President, Prof. T. Kishi, the Vice-President, Dr. M. Kitagawa and other staff at NIMS. The delegation comprised Prof. O. Adewoye, DG, NASENI, Prof. P. A. Onwualu, DG, RMRDC, Prof. R.A. Boroffice, DG, NASRDA and Dr. G. N. Onuoha. The delegation had a tour of Nanoscale Material Centre, Biomaterials Centre and the Nano System Functionality Centre.

Pencils

What is lead pencil?

In the year 1564, a hurricane across the British Isles uprooted a giant tree and exposed a black substance. A farmer, by chance, discovered that the black stuff made marks that would not wash off easily. Soon he and other farmers began to use the substance to mark sheep. The material was graphite but Scientists who examined it

dubbed it 'plumbago', the Latin word for a lead ore [24]. The term 'lead' has stuck till today.

The economic well-being of any nation hinges on its ability to transform resources, especially natural resources, to goods that satisfy human needs. It goes without saying, that the natural resources a country has are factories in waiting. Where a nation fails to add value to her natural resources, they remain dormant factories.

Nigeria has huge reserves of various natural resources. Our inability to key into the new and emerging technologies and therefore commercialize our low hanging fruits has forced us to remain a consumer nation. The immediate result is that we remain an import dependent nation, with the attendant problems of capital flight, lack of employment opportunities, low private sector activity etc.

Graphite is one of Nigeria's solid mineral resources [25]. In an effort to beneficiate graphite for the production of crucible pots for our foundry furnaces in PRODA, we had a serendipity: we isolated a by-product that is one of the active ingredients for pencil production.

Pencil is one of the essential working materials discovered by man in the history of writing. It is a truism that any individual who has had a formal education must have, at one time or the other, used pencils. China is currently the leading exporter of pencils to Nigeria, followed by Britain and Germany. It is estimated that for children of school age alone, Nigeria spends between 54.5m and 91m USD annually to import pencil from China alone.

All the basic raw materials (graphite, clay and wood) required for the production of pencils have been identified to exist in sufficient quantities in Nigeria. The graphite deposits are in Taraba, Niger, Adamawa, Kaduna, Bauchi and Cross River states. The clay deposits are in Imo, Abia, Enugu, Anambra and Ebonyi.

Pencil graphite cores or leads are made by mixing graphite powder with clay and binders, then firing in a furnace [26]. Different types of pencil are achieved by blending varying proportions of the graphite powder and clay to create different degrees of hardness or blackness. The 'H' stands for hardness, while 'B' stands for blackness. 'HB' stands for hard and black pencils. The hardest is 9H and hardness reduces progressively down to H. HB is middle of the road and the blackness progresses from 'B' up to 9B, which is the softest. Hence, the harder a pencil, the more clay it contains.

The most commonly used pencils for schools are the 2B, which is fairly soft, contains more graphite, leaves a dark black mark and more conductive. For shading of WAEC and JAMB objective answer scripts however, the HB, which has less graphite and therefore less conductive is preferred.

The treatment of graphite ore depends on the nature of its occurrence, including the fixed carbon content, FC, associated mineral oxides and particle size characteristics. Most Nigerian natural graphite ores contain approximately 30% fixed carbon and occur along with metamorphic rocks and metamorphosed lime stone. On analyses, they are found to constitute principally inorganic oxides like SiO_2, Al_2O_3, Fe_2O_3, Na_2O, CaO, K_2O, MgO, etc. These impurities necessitate the need for purification prior to use in pencil core production.

Comminution and Beneficiation, in the main, serve to remove these metallic mineral oxides from the graphite ore, using water and hydrocarbon solvents in a flotation cell.

Pencil Clay

Clay is a generic word for so many earth materials, distinguished by their plasticity, refractoriness, particle size, constituent minerals etc, that dictate their properties and use. Pencil clays have some

characteristics that border on such physical properties as density, bulk/apparent density, porosity, moisture content, permeability, weather resistance, etc.
Consideration is also given to such mechanical properties as elasticity, plasticity, rupture strength/brittleness, etc.

Some Nigerian clay deposits that were studied showed satisfactory results and include samples from Nsu, Nkwumeato, Enugu, Ukpor and Giru.

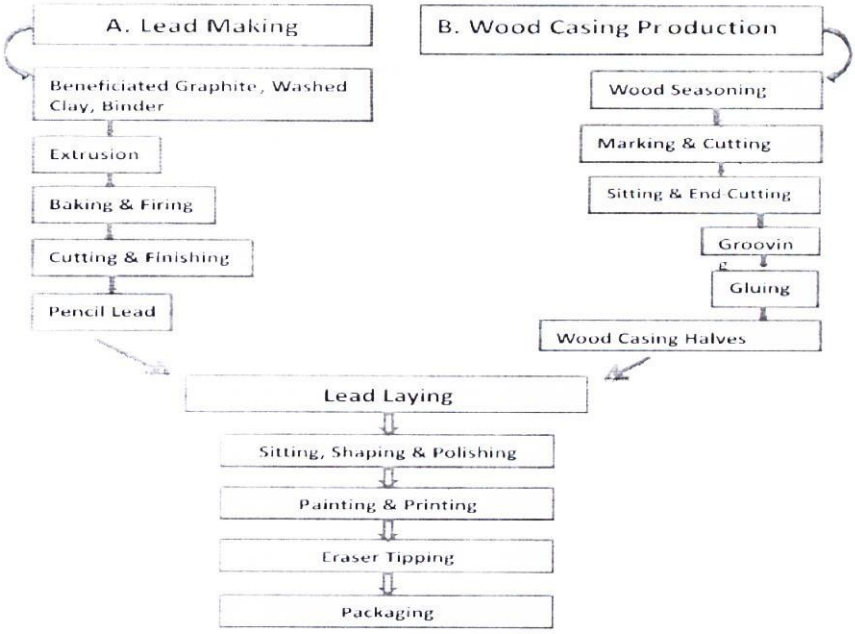
Pencil Wood

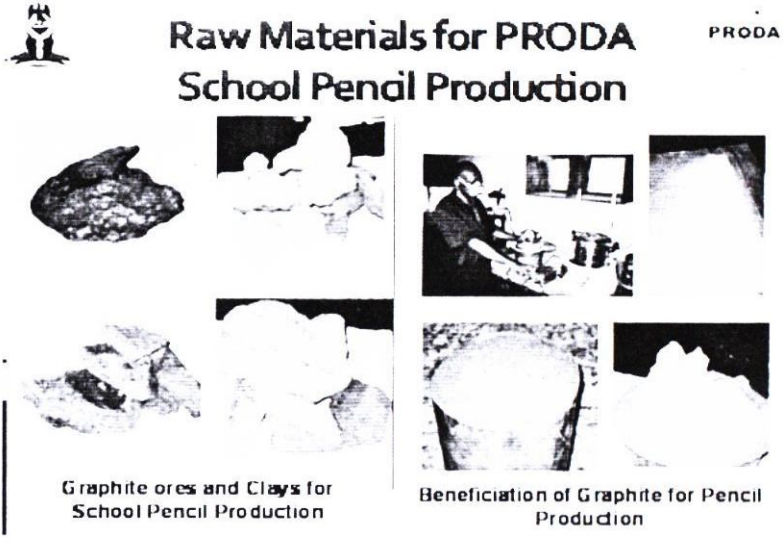
Pencils are encased in woods made from fine incense cedar woods. There are many factors that govern the choice of wood for pencil casing. These include but not limited to: (i) wood type and age, fibre lengths, sizes and distribution, (ii) fibre entanglements and shapes-longitudinal, vertical and intertwining, (iii) wood textures, (iv) wood hardness, (v) humidity and temperature effects (vi) ease of wood preparation and treatment, etc.

Because the incense cedar wood has majority of the desired properties, it has remained the choice of many pencil manufacturers.

Pencil production can be separated into 5 major groups – lead making, wood work, lead laying, shaping and finishing.

The Pencil Production Flow Chart is given overleaf:

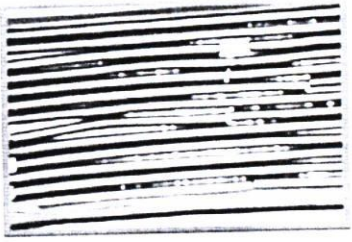

A. Lead Making
Beneficiated Graphite, Washed Clay, Binder
Extrusion
Baking & Firing
Cutting & Finishing
Pencil Lead
B. Wood Casing Production
Wood Seasoning
Marking & Cutting
Sitting & End Cutting
Groovin
Gluing
Wood Casing Halves
Lead Laying
Sitting, Shaping & Polishing
Painting & Printing
Eraser Tipping
Packaging

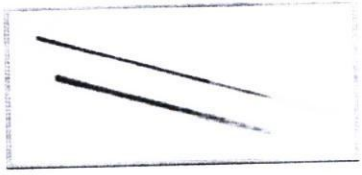

Raw Materials for PRODA School Pencil Production
PRODA
Graphite ores and Clays for School Pencil Production
Beneficiation of Graphite for Pencil Production

Samples of PRODA School Pencil

PRODA

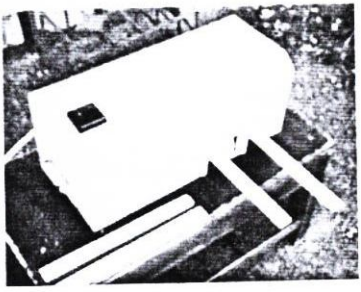
- PRODA School Pencil Production Project is an off-shoot of technologies for the Beneficiation and Utilization of Nigerian Natural Graphite Ores.
- PRODA has the capacity to produce School Pencils of HB and 2B types



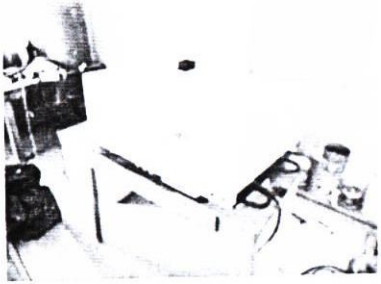


EXTRUDED PENCIL LEADS

PRODA



Novel Prototype Pencil Grooving M/C



Novel Prototype Pencil lead Extrusion M/C

PRODA Finished Pencils

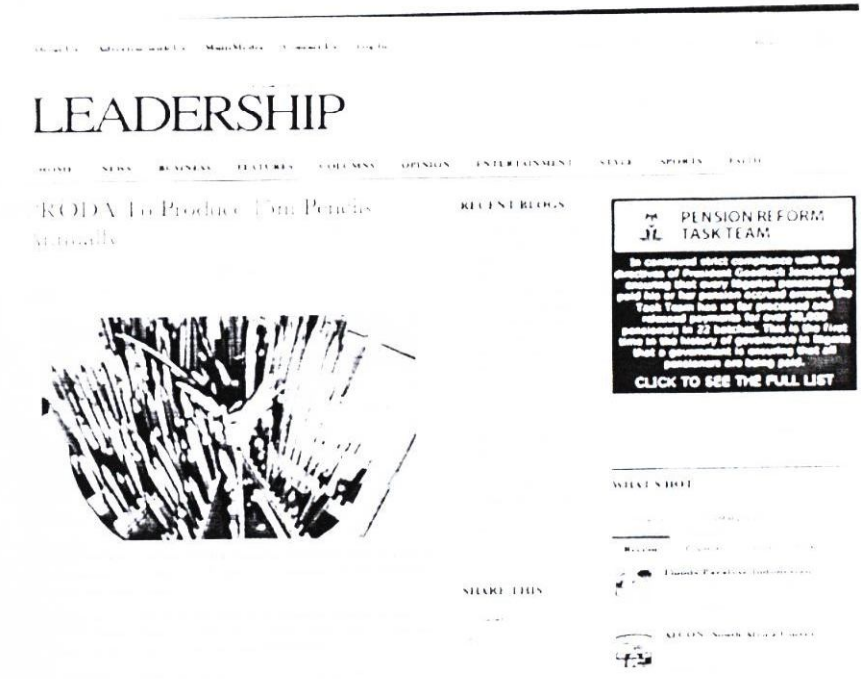
In PRODA, we followed the flow chart rigorously at bench scale up to and including painting and printing. We exhibited our samples at trade fairs, product Exhibitions and at the National Council of Science and Technology, NCST. We made noise everywhere and challenged Government on why the local production of pencils would not be encouraged.

The issue of mandate came up. Some protagonists argued that the role of a government establishment like PRODA should be to conclude research findings and pass on the results to entrepreneur to commercialize. I stood stoutly to challenge them and reminded them of how many such results that never saw the light of day. I must give credit to the media because they championed our course.

Then the National Assembly summoned me on the issue. I was either to convince them to make budgetary provision for it or the matter will be put to rest *sine die*. We discussed in detail and compared the position of Nigeria as a developing nation and the position of the nations that had passed through the crucible. I had personally visited and pried into the secret of the success stories in Japan, China, Israel, Indonesia, Malaysia, South Korea, the United Kingdom and the USA. These nations had one thing in common: their Governments invested heavily in Research and Development.

In the face of the harsh economic situation facing investors in Nigeria, Government must bear some of the risks and provide venture capital. When the product is fully developed and popularised, then local investors could key in and commercialize. In the case of pencils, we proposed to build a pilot in PRODA and thereafter replicate it in each of the six geopolitical zones of the Federation.

I am glad to inform that they bought the idea and made the budgetary provision in 2011 financial year. As hard as it is to achieve budgetary provision, it is even harder to achieve funding. But I give the glory to the almighty God that before the expiration of my tenure, we had commenced installing the machines in what will be the first pencil making facility in West Africa.

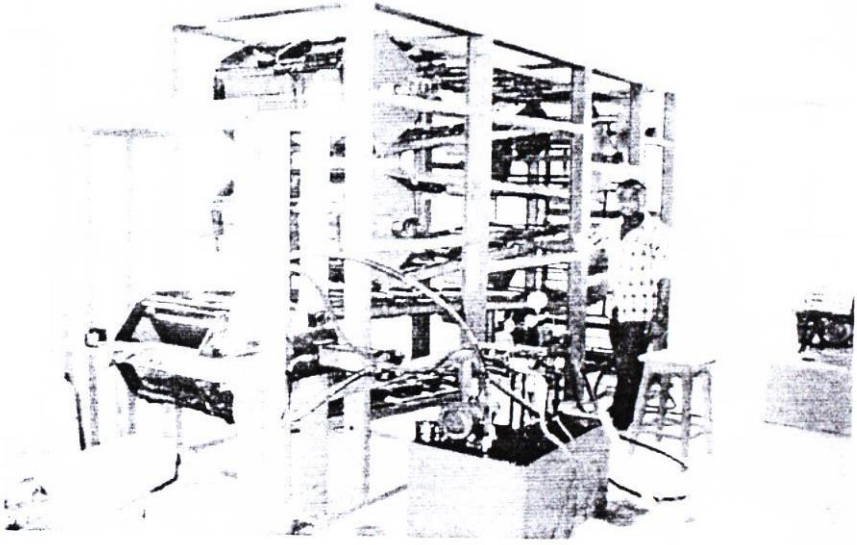

LEADERSHIP

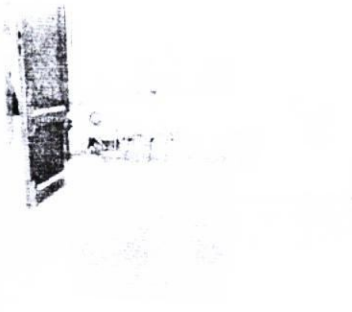
PRODA To Produce One Pencils

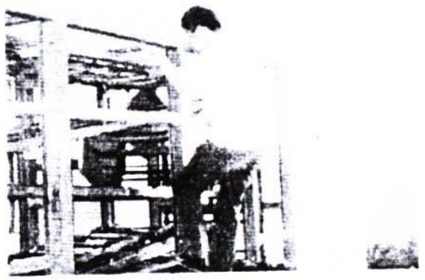
PENSION REFORM TASK TEAM

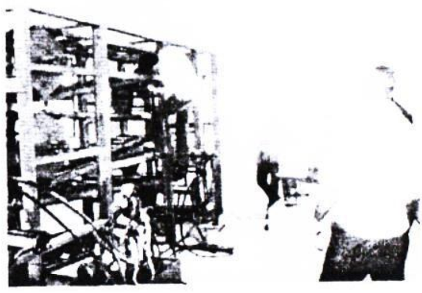
CLICK TO SEE THE FULL LIST

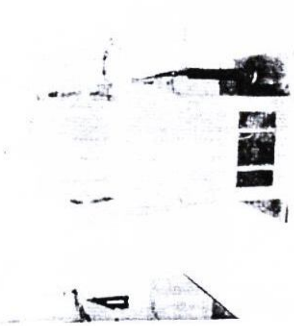
PRODA SCHOOL PENCIL MAKING MACHINES

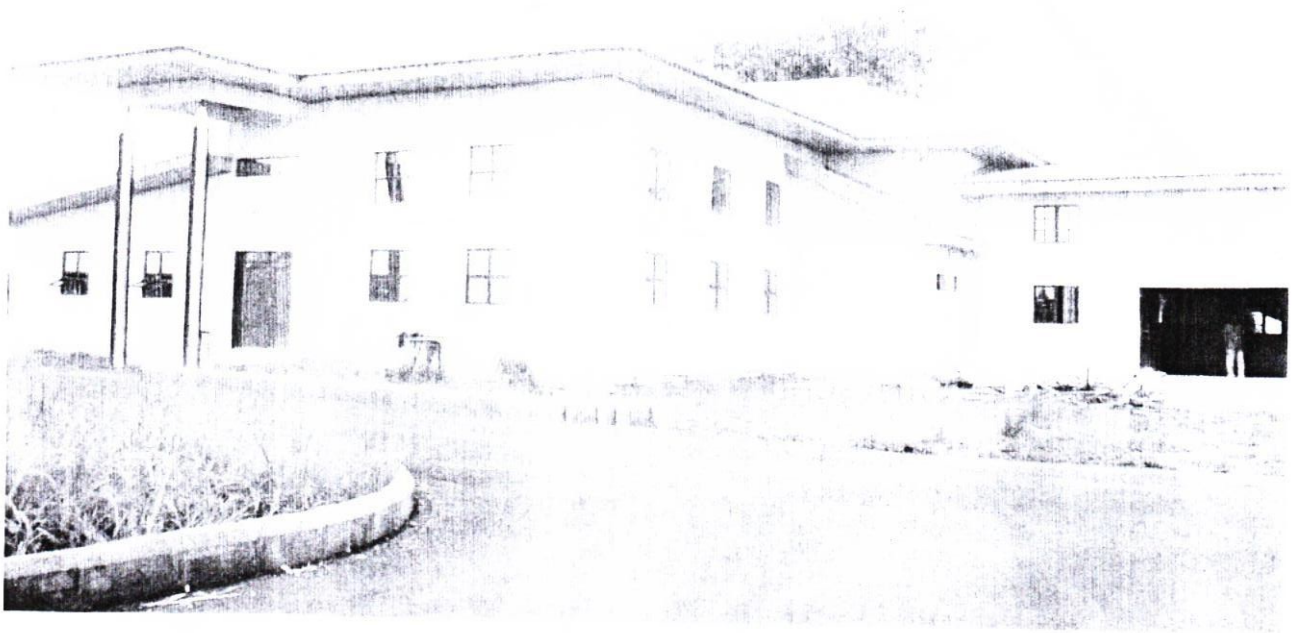












PRODA SCHOOL PENCIL PRODUCTION FACILITY

CONCLUSION.

My concluding remark is just to say that, as a nation, we are where we are today because we have failed to put Research and Development in its proper pedestal. A Chinese proverb has it this way:

> '***When planning for a year, plant corn***
> ***When planning for a decade, plant trees***
> ***But when planning for a life time, train and***
> ***educate the citizenry***'

Global trends in economic development and poverty reduction indicate a consistent empirical correlation with a nation's level of technological base. Nigeria, in spite of its enviable abundant natural resources – large fertile land area, solid minerals, proven reserves of oil and gas, intellectual endowment, etc. is still considered one of the twenty poorest countries of the world.

It is tempting to argue that the global effects of industrialization have placed us in a vicious cycle of a technological quagmire. This argument, however, is punctured by the development trends of countries like India and Malaysia, with similar experiences as Nigeria yet less endowed in natural resources. These countries have overcome their own difficult situations and attained positions of respect in the world map of technologically and industrially developing countries.

Table 2 gives a clear picture of Nigeria's dilemma. If we blame our colonial masters for our inability to key into stages 1, 2 and 3, who do we blame for failure to key into stages 4 and 5?

DEVELOPED NATIONS					NIGERIA
STAGE	AGE	ERA	TECHNOLOGICAL SIGNIFICANCE	PRODUCTS IN VOGUE	CURRENT TRENDS
1	1770 – 1830	Industrial Revolution	Mechanization (Foundry Technology gained prominence)	- Textiles - Chemicals - Iron castings - Machines, etc	Heavy dependence on foreign technology and equipment
2	1830 – 1880	Victorian Prosperity	The use of Steam power	- Steam engines - Steam ships - Rails - Heavy industry, etc	Inadequate infrastructure
3	1880 – 1940	The Great Depression	Electrical Machinery Engineering	- Electrical components - Steel making, etc	Lack of heavy industry
4	1940 – 1990	Golden Age	Evolution of Mass production outfits	- Automobiles - Trucks - Tractors - Aircraft, etc	Lack of capital base
5	1990 to date	Post-Cold War	Information Technology	- Computers - Electronics - Robotics - Satellites - Genetic engineering - Biotechnology - Nanotechnology, etc	Lack of manpower, poor infrastructure , etc

The Nigerian nation will out-live the oil deposits and our economy, like the rest of the world, will be knowledge driven. Human capital development is no longer an option. It is an imperative and the time to address it is now.

RECOMMENDATIONS

I humbly make the following recommendations:

- ✓ Government at ALL levels – Federal, State and Local Government – should develop the political will and create the enabling environment for the sustenance of Research and Development activities..
- ✓ The financial institutions must be prepared to support entrepreneurs with proven capabilities to translate results of R & D into ventures that will create employment and alleviate poverty.
- ✓ There must be a guided and monitored Government policy to protect local entrepreneurs.
- ✓ The media, the fourth estate of the realm, must partner with stakeholders in creating awareness and promoting successful results of R & D.
- ✓ That since Technology is the application of basic Science in solving the day to day problems that arise, Governments must provide the necessary support to ensure that basic Sciences are adequately taught in our primary, Secondary and Tertiary institutions.

MEMBERSHIP OF PROFESSIONAL BODIES.

I belong to the following professional bodies:
Fellow, Institute of Chartered Chemists of Nigeria, FICCON
Fellow, Chemical Society of Nigeria, FCSN
Member, Royal Society of Chemistry, RSC
Member, Corrosion Association of Nigeria, CAN
Member, Institute of Public Analysts of Nigeria, IPAN
Member, Science Association of Nigeria, SAN
Member, American National Board for Business Incubation.

COMMUNITY SERVICE

I have rendered the following services at different times in my career:

- General Secretary, Owerri Sports Club, Owerri, 1988 to 1990.
- Captain, Lawn Tennis Section, Owerri Sports Club, 1991 to 1992.
- Chairman Caretaker Committee, Nov., 1992 to April, 1993.
- The National Republican Convention, NRC, Nkwerre LGA, Imo State.
- Member, Imo State Executive Council, 1994 – 1996.
- Member, National Council on Agriculture, 1994 – 1996
- Vice-Chairman, Imo State ADP Executive Council, 1994 - 1996
- Patron, FUTO Senior Staff Club, 1995
- Convocation Lecturer, Alvan Ikoku Federal College of Education, Owerri, October, 2010.
- Patron, Owerri Sports Club, Owerri
- Patron, Safari Club, Owerri.
- Patron, RIGAN Games.

HONOURS AND AWARDS

I received awards and honours from numerous bodies. They include:

- Award for Excellent Economic Development by the TimeNEWS Magazine Editorial Board, 2011.
- Award of Excellence for Contribution to the Development of Science & Technology in Nigeria by the Nigerian Institute of Physics, 2010.
- Award of Excellence in Recognition of Outstanding Achievements, Exceptional Leadership and Contribution to Project Research Development and Industrialization in Nigeria by the Student Chemical Society of Nigeria, National Secretariat, 2005.

  Community Service Award in Recognition of Commitment to the Advancement of National Development by the Rotary Club of Enugu Municipal, District 9140.
- Conferred with the traditional title of 'Chika Dibia' by the Ogbor-Ugiri Autonomous Community, Imo State, Dec. 1994.

  Nze N'Ozo Title of 'Ike-Oha Nkwerre' by the Nze n'Ozo title Holders of Nkwerre, Imo State, April, 1995.
- Conferred with the Chieftaincy title of 'EBUBEDIKE' by the entire traditional rulers of old Nkwerre LGA (now Nkwerre and Nwangele) of Imo State, May, 1995.
- Knight of St. Christopher, (KSC.), September, 1995 Church of Nigeria, Anglican Communion, Orlu Diocese.
- Justice of Peace, (JP), Imo state of Nigeria, 1996.

- Award for Excellence for Outstanding Contributions to the Advancement of Nike Diocese of the Anglican Communion, Church of Nigeria, 2009.

- Award of Honour in recognition of Selfless Service to the Church and Humanity by our Lady Queen of Peace Catholic Parish, Egbeada, Owerri, 2010

ACKNOWLEDGEMENT

I give all glory to the Almighty God for all He has done to and with my life. Five times during this short life, He has pulled away from tragedies that could have resulted to death. And that is why I live each moment as if it will be the last. He has been more faithful than I can recount. All I do is to acknowledge Him in all situations. He is Omni potent, Omni Science and Omni Present.

During the eight year period I was on leave of absence, there was no week I did not undertake a trip, either by air, by sea or by road. Every weekend during the period, except I was out of the country, my family either travelled to Enugu or I returned to Owerri to see them. We give Him the glory for all the journey mercies. For the good health, supplies and peace of mind, we reaffirm our commitment to worship Him and Him alone all our lives.

I acknowledge and thank my wife (in fact, my junior sister), Lady (Lolo) Helen Onyege Onuoha.

When people tell me, and it is always happening, that my wife is a very charming and amiable woman, I acknowledge it with utmost gratitude to the Almighty God. Yes, she is very supportive, loving and caring. All the periods I have had to be away from home, she stood in firmly and played the role of mother and father with fortitude and commitment. I thank God very much for His gift of a good wife.

But I must say this too. There are only two beings in all my life that are capable of making me tremble. The first is God, the Supreme Being who made me and rules me. The second is my wife, the mother of my children. She is on the list because she alone has the power to incite my children against me. And you know, any man that the children turn against is completely finished.

Without mincing words, I affirm to you today that I do not take her good nature for granted and that any time she frowns, I tremble.

Between us, we have five children (my best friends). Onyinyechi Ecstacy Onuoha has just left for her NYSC programme, after graduating in Chemical Engineering from this University. Amarachi Wendy is studying medicine in the University of Legon. Uchenna Magret is about writing her WAEC in the Air Force Comprehensive School, Agbani. Chinakwere Chimobi Agamadodaigwe is in the JS3, also at Agbani with the elder sister. Onuoha Nkemjika Onuoha is in JS2 at the PEACE Centre in Owerri. Ugochukwu Obong is a graduate of Theatre Arts from the Imo State University.

I am led to believe and hope that in spite of my stern looks and disciplinary disposition, my children appreciate that I love them immeasurably.

Mrs Joyce Onuoha, my step-mother was always a support pillar. She made life a lot easier for me after the death of my father, as I combined graduate studies with running the home my father unceremoniously left in his prime. My sisters Egondu, Nkechi and brothers, Emeka, Chukwudi and Chimezie have been sources of inspiration. I thank you all and ask God to meet you at your points of need.

I thank my father-in-law, Chief Bernard Onuoha Egbuchulam and the entire Egbuchulam-Chimezie clan. They are wonderful in-laws. Chief (Engr.) Chinaka Uzoho and Dr. Chinakwe Onuoha are acknowledged for their supports, especially after the death of my father. Mr. George Ikoroha (late) is remembered and specially thanked for helping to administer my father's estate while I faced studies.

I thank the Vice-Chancellor, Prof. C. C. Asiabaka, the deputy Vice-Chancellors, the other principal officers and the entire University

community for your warm welcome on my return. I appreciate all of you and I reiterate what I had said earlier on my return. I returned to a FUTO that is by far better than the FUTO I left. Better infrastructure, better staffing, improved management-style, gender sensitive, IT compliant, just name it. I congratulate you all and I wish us all more goodies to come.

My thanks also go to the Honourable Ministers of Science & Technology, past and present, the Permanent Secretaries and their team. I fondly remember my colleagues, the Directors-General in the Science & Tech. family. I cannot forget the Management and staff of PRODA. At PRODA, I had a mix of pessimists and optimists. I enjoyed working with both because each motivated me in its peculiar way. I will make special mention of Dr. Charles Agulanna, who took over from me, Mrs. Pauline Chijioke, Dr. (Mrs) Ngozi Onyemelukwe, Lady Akagu, Igwe David Ezemokwe, Justin Nzerogu, Goddy Njom, Chino Ogbonna and Engr. GOC Ihezie, whom I nicknamed Mr. Pencil. I will always remember you all in my daily prayers.

I thank my academic father, Prof. Ikenna Onyido. You came into my academic life at a time I was contemplating whether to call it quits or continue. I owe it to you that I continued. You had an enviable mien that endeared any follower to you. I salute too, your good wife who gave all the home support while you tarried hours unending in the laboratory.

My colleagues in the Department of Chemistry must be acknowledged. The Head of Department, Prof. U. U. Egeronu, our Oga Prof. Cliff Anunuso, Prof. Sam Onyiriuka, Prof. Emma Ejike, Prof. Ogwuegbu and Prof. PC Njoku, my bosom friend, Dr. Atu Ayuk, Dr. Eva Ejele, Dr. Emeka Oguzie, my man Belonwu Okolue and the rest others that, for sake of time, I can't mention are acknowledged. Our technical and administrative staff are appreciated. I will not fail to mention Prof. A. I Onuchukwu. He gave quality academic leadership while he was with us.

The Dean of Science, Prof. Osuala and all in his team, I thank you for the smooth running of the School. We appreciate how tough it is but we know too, only the tough keep moving. The Chairman Committee of Deans, Prof. Emma Anyanwu, the Deans of Schools and the Dean of Students' Affairs, the Directors and Heads of Academic and non-Academic Departments in the University, I salute you all.

My academic peers, Prof. Collins Ubochi of the Imo State University, Prof. Joe Nwabueze and Prof. Sam Kakulu, immediate past and present DVCs respectively in University of Abuja and Prof Joe Woods in the University of Ibadan. We all have reasons to thank God for crowning our efforts.

The Chairman and members of the University Lecture series, I doff my hat. Prof. Iwuala has been more than just an academic. The Ahiajoku Committee once described him as a Ministry of Education. I agree entirely with them.

All works and no play makes Jack a dull boy. I always find time to recreate, exercise and socialise. I belong to the Owerri Sports Club, the Safari Club, Enugu Sports Club, Nkwerre Country Club and was also an active member of the moribund FUTO Senior Staff Club.

I cannot quantify the benefits I have garnered from my membership of these clubs. In addition to having a sound mind in a sound body as the motto of Safari Club alludes, I have gained tremendous social relationships. I seize opportunity today to say to my numerous club members, 'thank you for always being there for me'.

Special mention must be made of Rear Admiral Alison Amaechina Madueke and his siblings, especially Chika, Obi and Chike. This family took a natural likeness for me and has done so much to raise me. God will not allow your light to dim.

I reserved the last mention for my parents, Josephine Ogonna (nee Ogundu) and Emmanuel Ukaegbu Onuoha, both of blessed memory. I am not questioning God but I really wish they were here today.

They both loved education and did everything within their means to offer education, not only to their children and relations but indeed to anybody around them. They were both teachers and my mother continued to teach till she died.

The search for greener pastures and the need to make ends meet forced my father to quit University teaching. I still fondly clutch his Ph. D. thesis and I always remembered his chiding me 'I did not tarry long enough to be a Professor. You owe it to me'. I really wish he was here.

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PREVIOUS INAUGURAL LECTURES

S/No.	LECTURE	TOPICS	DATE
1.	Prof. C.O.G. Obah	*"Communication in the Service of a Nation".*	Dec. 12, 1986
2.	Prof. E.O.I. Banigo	*"Food Processing and Preservation: Paths to Self Sufficiency".*	Jan. 18, 1989
3.	Prof. V.O. Nwoko	*"Where Rust Doth Corrupt".*	Nov. 14, 1990
4.	Prof. S.C.O. Ugbolue	*"In the Throes of Polymer and Textiles".*	Dec. 11, 1996
5.	Prof. O.O. Onyemobi	*"Mineral Resources Exploitation, Processing and Utilization: A Sine Qua non for Nigeria's Industrial Development".*	Jul. 17, 2002
6.	Prof. A.B.I. Udebibie	*"Insearch of Food: FUTO and the Nutritinal Challenge of Carnavalia Seeds".*	Sept. 18, 2003
7.	Prof. E.O. Okorafor	*"Expendable Polystyrene Pattern Casting Process: A Revolution in Metal Casting".*	March 17, 2004
8.	Prof. P.B.U. Achi	*"Acquisition of Indigenous Machinery Design Manufacturing and Control Technology. The Engineering Education and Training Perspectives".*	June 2, 2004
9.	Prof. M.I. Nwufo	*"Securing the Harvest to Ensure Food for All: A Plant Pathologist's Perspective".*	July 28, 2004
10.	Prof. M.U. Iloeje	*"The Chicken or the Egg: Nature and Nurture: New Genetic Spread Sheet and Gene Pool in the Breeding and Evolution of A New Nigerian Man".*	Nov. 17, 2004
11.	Prof. J.O. Uzuegbu	*"Salvaging our Food from Fungi Rot to Ensure Food Security".*	Oct. 29, 2008
12.	Prof. C.S. Nwadiaro	*"Inland Water Data Base As A Sine Qua Non for Fisheries Development in Nigeria"*	May 7, 2009
13.	Prof. M.C. Ofoh	*"Food Security and Mitigation of Climate Change Through Ecosystem-Based Agriculture".*	May 27, 2009
14.	Prof. B.O.Esonu	*"Unconventional Feed Resources for Livestock Development and Food Security: Paradigms for Nigerian Livestock Industry".*	June 24, 2009

15.	Prof. E.O.P. Akpan	*"Project Management: A Catalyst for Rapid Industrial Development for Emerging Economies".*	Oct. 10, 2009
16.	Prof. C.C. Asiabaka	*"Scaling-Up Agricultural Technologies for Food Security and Poverty Reduction: Whose Knowledge Counts: The Farmer or the Scientist?".*	Feb. 15, 2010
17.	Prof. C.O. Owuama	*"Foundation Engineering in a Difficult Environment"*	June, 10, 2010
18.	Prof. N.N. Onu	*"Training in Geophysics: The Challenges of Oil Exploration, Gully Erosion and Water Resources".*	March 16, 2011
19.	Prof. (Mrs) H.C. Nwigwe	*"Aquatic Resources Management: A Tool for Food Security in Nigeria".*	March 30, 2011
20.	Prof. C. N. Ubbaonu	*"Enhancing Acceptability and Economic Value of Local Foods through product Development and Promotion".*	April 27, 2011
21.	Prof. G. C. Eheduru	*"Towards a Unified World View: the "god particle" and the Traditional Christian Belief".*	October 4, 2012
22.	Engr. Prof. E. E. Anyanwu	*"New Energy Technology Revolution: A Catalyst for Sustainable National Development".*	Oct. 29, 2012