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Highlights

Electric Theory of Tornado

High Temperature Adhesive

Design and Implementation

Deep Submicron Technology

Discovering Thoughts, Inventing Future

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Electric Theory of Tornado, Protection from Tornado

By Alexander Bolonkin
CUNY, USA

Abstract- The author develops a new theory of tornado stability. He show that it is the high electric voltage between clouds and ground surface which produces the intensive electron/ion flow which creates the air stream which sucks off (pumping) air from the inside tornado channel and makes the tornado stable. If we want to destroy tornado stability we must decrease the electric intensity into the tornado channel. The simplest method is using conductive wire to connect the top funnel of tornado with ground. For this method, the top end of wire must have a large conductive area (air balloon or wing dirigible with conductive layer), the lower end of wire must have good contact with wet ground. The row from these conductive wires having step 150 – 200 m and altitude 200 – 300 m can protect villages, towns and important installations such as the nuclear electric station and military bases from tornados.

Keywords: tornado, stability of tornado, protection from tornado, hurricane, bolonkin.

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ELECTRICTHEORYOFTORNADOPROTECTIONFROMTORNADO

Strictly as per the compliance and regulations of :

Electric Theory of Tornado, Protection from Tornado

Alexander Bolonkin

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Keywords: tornado, stability of tornado, protection from tornado, hurricane, bolonkin.

I. Introduction

a) Tornado

A tornado is a violently rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud. Tornadoes come in many shapes and sizes, but they are typically in the form of a visible condensation funnel, whose narrow end touches the earth and is often encircled by a cloud of debris and dust. Most tornadoes have wind speeds less than 110 miles per hour (177 km/h), are about 250 feet (76 m) across, and travel a few miles (several kilometers) before dissipating. The most extreme tornadoes can attain wind speeds of more than 300 miles per hour (483 km/h), stretch more than two miles (3.2 km) across, and stay on the ground for dozens of miles (more than 100 km).

Tornadoes have been observed on every continent except Antarctica. However, the vast majority of tornadoes occur in the Tornado Alley region of the United States, although they can occur nearly anywhere in North America. They also occasionally occur in south-central and eastern Asia, northern and east-central South America, Southern Africa, northwestern and southeast Europe, western and southeastern Australia, and New Zealand. Tornadoes can be detected before by recognizing patterns in velocity and reflectivity data, such as hook echoes or debris balls, as well as by the efforts of storm spotters In the United States, tornadoes are around 500 feet (150 m) across on average and travel on the ground for 5 miles (8.0 km).

Lighting conditions are a major factor in the appearance of a tornado. Night-time tornadoes are often illuminated by frequent lightning.

There is mounting evidence, including Doppler on Wheels mobile radar images and eyewitness accounts, that most tornadoes have a clear, calm center with extremely low pressure, akin to the eye of tropical cyclones.

Tornadoes emit on the electromagnetic spectrum, with sferics and E-field effects detected. There are observed correlations between tornadoes and patterns of lightning. Tornadic storms do not contain more lightning than other storms and some tornadic cells never produce lightning. More often than not, overall cloud-to-ground (CG) lightning activity decreases as a tornado reaches the surface and returns to the baseline level when the tornado lifts. In many cases, intense tornadoes and thunderstorms exhibit an increased and anomalous dominance of positive polarity CG discharges. Electromagnetic and lightning have little or nothing to do directly with what drives tornadoes (tornadoes are basically a thermodynamic phenomenon), although there are likely connections with the storm and environment affecting both phenomena.

In addition to winds, tornadoes also exhibit changes in atmospheric variables such as temperature, moisture, and pressure. For example, on June 24, 2003 near Manchester, South Dakota, a probe measured a 100 mbar (hPa) (2.95 inHg) pressure decrease. The pressure dropped gradually as the vortex approached then dropped extremely rapidly to 850 mbar (hPa) (25.10 inHg) in the core of the violent tornado before rising rapidly as the vortex moved away, resulting in a V-shape pressure trace. Temperature tends to decrease and moisture content to increase in the immediate vicinity of a tornado.

b) Damage from Tornado

The tornadoes killed thousands, injured ten thousands peoples, damages ten billions USD dollars. Some data about tornado disaster are below.

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Tornado Disaster Statistics from 1980 - 2008	
Number of events:	182
Number of people killed:	4,780
Average people killed per year:	165
Number of people affected:	12,710,204
Average number of people affected per year:	438,283
Economic Damage	$31,510,661,000
Economic Damage per year	$1,086,575,000

Issue : http://www.statisticbrain.com/tornado-statistics/

This article lists various tornado records. The most extreme tornado in recorded history was the Tri-State Tornado, which roared through parts of Missouri, Illinois, and Indiana on March 18, 1925. It was likely an F5, though tornadoes were not ranked on any scale in that era. It holds records for longest path length at 219 mi (352 km), longest duration at about 3.5 hours, and fastest forward speed for a significant tornado at 73 mph (117 km/h) anywhere on Earth. In addition, it is the deadliest single tornado in United States history (695 dead). It was also the second costliest tornado in history at the time, but has been surpassed by several others non-normalized. When costs are normalized for wealth and inflation, it still ranks third today.

The deadliest tornado in world history was the Daulatpur - Salturia Tornado in Bangladesh on April 26, 1989, which killed approximately 1,300 people. Bangladesh has had at least 19 tornadoes in its history kill more than 100 people, almost half of the total for the rest of the world (fig.1).

Figure 1 : Typical Tornado

The United States gets about 1000 recorded tornadoes every year. From May 2 to 8, 1999, a large tornado outbreak took place across much of the Central and parts of the Eastern United States. During this week-long event, 152 tornadoes touched down, including one in Canada. The most dramatic events unfolded during the afternoon of May 3 through the early morning hours of May 4 when more than half of these storms occurred. Oklahoma experienced its largest tornado outbreak on record, with 70 confirmed. The most notable of these was the F5 Bridge Creek–Moore tornado which devastated suburban communities to the southwest of Oklahoma City. The tornado killed 36 people and injured 583 others; losses amounted to $1 billion, making it the first billion-dollar tornado in history. Overall, 50 people lost their lives during the outbreak and damage amounted to $1.4 billion.

c) Lighting

Cloud-Ground (CG) lightning can occur with both positive and negative polarity. The polarity refers to the polarity of the charge in the region that originated the lightning leaders. An average bolt of negative lightning carries an electric current of 30,000 amperes (30 kA), and transfers 15 coulombs of electric charge and 500 megajoules of energy. Typically, lightning at up to 100 million volts, large bolts of lightning can carry up to 120 kA and 350 coulombs. Positive lightning typically makes up less than 5% of all lightning strikes. . Plasma temperatures in lightning can approach 28,000 kelvins and electron densities may exceed $10^{24}/m^3$. A bolt of positive lightning may carry an electric current of 300 kA and the potential at the top of the cloud may exceed a billion volts — about 10 times that of negative lightning (fig.3)

Figure 2 : Lighting

d) Atmospheric Electricity

Experiments have shown that the intensity of this electric field is greater in the middle of the day than at morning or night and is also greater in winter than in summer. In 'fine weather', the potential, aka 'voltage', increases with altitude at about 30 volts per foot (100 V/m), when climbing against the gradient of the electric

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field. This electric field gradient continues up into the atmosphere to a point where the voltage reaches its maximum, in the neighborhood of 300,000 volts. This occurs at approximately 30-50 km above the Earth's surface. From that point in the atmosphere up to its outer limit, nearly 1,000 km, the electric field gradient produced in the lower atmosphere either ceases or has reversed.

A simple calculation gives the result that when such a collector is arranged for example on the ground, and a second one is mounted vertically over it at a distance of 2000 meters and both are connected by a conducting cable, there is a difference in potential in summer of about 2,000,000 volts and in winter even of 6,000,000 volts and more.

e) Hurricane

A tropical cyclone (hurricane) is a rapidly-rotating storm system characterized by a low-pressure center, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain. Tropical cyclones typically form over large bodies of relatively warm water. They derive their energy from the evaporation of water from the ocean surface, which ultimately re-condenses into clouds and rain when moist air rises and cools to saturation.

At the center of a mature tropical cyclone, air sinks rather than rises. For a sufficiently strong storm, air may sink over a layer deep enough to suppress cloud formation, thereby creating a clear "eye" (fig.3). Weather in the eye is normally calm and free of clouds, although the sea may be extremely violent. The eye is normally circular in shape, and is typically 30–65 km (19–40 mi) in diameter, though eyes as small as 3 km (1.9 mi) and as large as 370 km (230 mi) have been observed.

The cloudy outer edge of the eye is called the "eyewall"(fig.6). The eyewall is where the greatest wind speeds are found, air rises most rapidly, clouds reach to their highest altitude, and precipitation is the heaviest. The heaviest wind damage occurs where a tropical cyclone's eyewall passes over land.

Scientists estimate that a tropical cyclone releases heat energy at the rate of 50 to 200 exajoules (1018 J) per day, equivalent to about 1 PW (1015 watt). This rate of energy release is equivalent to 70 times the world energy consumption of humans and 200 times the worldwide electrical generating capacity, or to exploding a 10-megaton nuclear bomb every 20 minutes.

The most intense storm on record was Typhoon Tip in the northwestern Pacific Ocean in 1979, which reached a minimum pressure of 870 mbar (652.5 mmHg) and maximum sustained wind speeds of 165 knots (85 m/s) or 190 miles per hour (310 km/h). Likewise, a surface-level gust caused by Typhoon Paka on Guam was recorded at 205 knots (105 m/s) or 235 miles per hour (378 km/h).

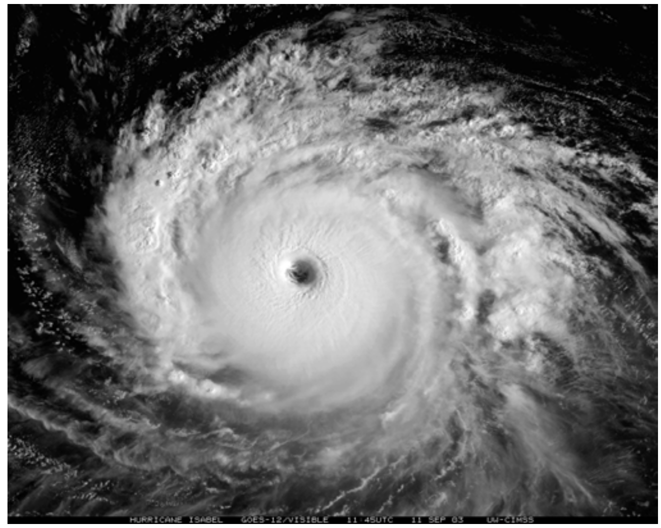

Figure 3 : Typical hurricane, Photo from outer space

II. Electric Theory of Tornado

Tornados (vortexes) killed, wounded, crippled thousands of people, destroyed, and damaged thousands of homes, made billions of dollars of losses. The theory of tornado has been researched for more than a hundred years. Only in the USA, the large state Agency NOAA, studied tornado and weather since 1807. We have an excellent mathematical theory of a vortex. However, we don't have a clear understanding of the nature and activity of tornados. The mathematical theory of the stability of the vortex requires the data of the outlet, influent the air. But researchers do not see the forces which pump or suck out the air from the internal core of tornado.

The author shows in this article that it is the electric intensity between clouds and ground (especially storm clouds and ground) which produces the electron (ion) strong vertical wind (flow) into tornado, which works as a pump inside tornado and makes the tornado stable.

Everyone can make this simple experiment in a kitchen sink or bathroom. If you fill the sink with a layer of water (2 – 3 cm) and open the drain, the water, at some point, creates a stable vortex. Opening the drain is important element of system. If you close it, the vortex disappears.

In the atmosphere, air has friction and typically a vortex losses energy. The air flow (leak of air inside vortex) compensates for the loss of vortex energy and supports its rotation. The flow of electrons (ions) inside of tornado creates the electric current which produces the circular magnetic field which also helps the vortex and his stability.

The schemata of a tornado is shown in fig. 4. It is a vortex located between charged clouds and the ground. The vortex contains a wall which rotates with high speed. According to the Law of Angular Conservation the linear speed of rotation increases and

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air pressure is lowered when the tornado radios decreases.

According this author's theory (see computation in theoretical section) a strong electric intensity between an altitude layer (clouds) atmosphere and the ground produces a powerful electro (ion) flow inside of tornado along its axis. The air suck off from inside wall of tornado. When electrons reach the surface, they go into ground the ions are neutralized and air go out between low end of tornado and ground surface. If ground has negative charge (cloud has positive charge), the electric intensity works as pump sucked off the air flow into cloud.

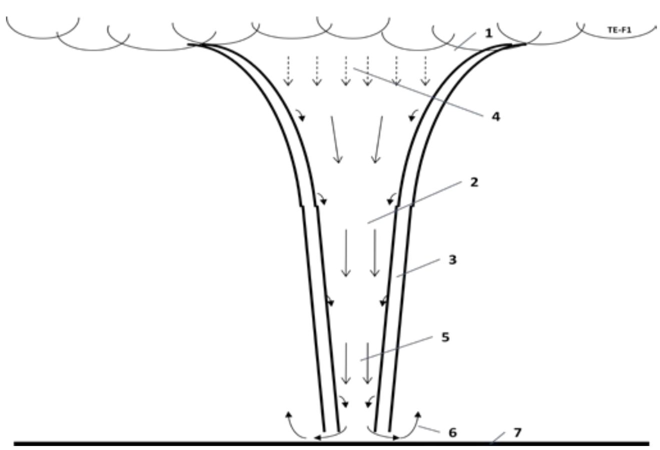

Figure 4 : Sketch of tornado. *Notations* : 1 – charged clouds; 2 – body of tornado; 3 – rotated wall of tornado; 4 – electric intensity; 5 – electron (ion) wind; 6 – exit of electron (discharged) wind; 7 – ground

III. Estimations and Computation

a) *Theory of Vortex*

The speed into a vortex wall may be estimated by equations (conservation of angular momentum):

$$V = r_o V_0 / r \qquad (1)$$

where V_0 is speed on a vortex surface, m/s; V is speed into vortex wall, m/s; r_o is radius of on a vortex surface, m; r is radios into the vortex wall, m.
The pressure into the vortex wall is

$$p = p_o - V^2/2 \qquad (2)$$

Where p is pressure into the vortex wall, N/m^2; p° is an atmospheric pressure, $p_o \approx 10^5$ N/m^2.

b) *Energy of Cloud*

The vaporization energy of 1 km2 is

$$E_v 1 = m\lambda \qquad (3)$$

where E_{v1} is the vaporization energy of 1 km^2, J; m is water mass in 1 km^2 of cloud, kg; $\lambda = 2.2{\cdot}10^6$ is specific energy of vaporizing, J/kg.××
The lift energy at altitude is

$$E_{L1} = mgh \qquad (4)$$

where g = 9.81 m/s^2 is Earth gravity; h is altitude of cload, m.

The electric energy as condenser having area 1 km2, distance 1 km and voltage 100 million volts the cloud has energy.

$$E_{e1} = 0.5_{\varepsilon o} SU^2/h \qquad (5)$$

Where $_{\varepsilon o}$ = 8.85·10^{-12} is electrostatic constant; S is area of condenser, m^2; U is voltage, V; h is altitude, m.

Example 1: For the rain gives 0.1 m water, the cloud of area 1 sq. km, located at altitude 1 km and charged up 100 million volts has energy:

1. Evaporation (condensation) energy is $E_{v1} = m\lambda = 10^8 \times 2.2{\cdot}10^6 = 2.2{\cdot}10^{14}$ J/km^2.
2. Lift energy is $E_{L1} = mgh = 10^8{\cdot}9.81{\cdot}1000 \approx 10^{12}$ J/km^2.
3. Electric energy $E_{e1} = 0.5\varepsilon o SU^2/h = 0.5{\cdot}8.85{\cdot}10^{-12}{\cdot}10^6{\cdot}10^{16}{\cdot}10^{-3} \approx 4.42{\cdot}10^7$ J/km^2.

For conventional cloud 10×10 km2 the energy is in 100 times more. The clouds can has altitude 200 m and energy in 5 times more.

The electric energy is small in comparison with evaporation and lifting energy but one is used only for stabilization of tornado.

c) *Electron (ion) Speed*

The electron speed about the air flow, gas (air jet) may be computed by equation:

$$j_s = qn\text{-}b\text{-}E + qD\text{-}(dn\text{-}/dx) \qquad (6)$$

Where js is density of electric currency about flow (jet), A/m2; q = 1.6×10-19 C is charge of single electron, C; n- is density of electrons (negative charges) in 1 m3; b - is charge mobility of negative charges, m2/sV; E is electric intensity, V/m; D- is diffusion coefficient of charges; dn-/dx is gradient of charges. For our estimation we put dn-/dx = 0. In this case

$$j_s = qn\text{-}b\text{-}E\,,\quad Q = qn\,,\quad v = bE\,,\quad j_s = Qv \qquad (7)$$

where Q is density of the negative charge in 1 m3; v is speed of the negative charges about flow, m/s.

The negative charge mobility for normal pressure and temperature T = 20oC is:

$$\text{In dry air } b\text{-} = 1.9\times10^{-4}\ \text{m}^2/\text{sV, in humid air } b\text{-} = 2.1\times10^{-4}\ \text{m}^2/\text{sV.a} \qquad (8)$$

If the air pressure is from 13 to 6×10^6 Pa, then the mobility follows the law

$$bp = const \qquad (9)$$

where p is air pressure. When air density decreases, the charge mobility increases. The mobility strength depends upon the purity of gas.

For normal air density the electric intensity must be less than 3 MV (E < 3 MV). Otherwise the electric breakdown may be.

If v > 0, the electrons (ions) accelerate the air (E > 0 the cloud spends energy (charge), works as ventilator). If v < 0 (E < 0), the cloud works as suck pump (back ventilator). If v = 0 (electron speed about air flow equals null), the electric resistance is zero.

Example 2 : Assume a voltage between a cloud and earth ground is U = 100 millions volt. Distance is D = 500 m. Than the average electric intensity is E = U/D = $10^8/500 = 2{\cdot}10^5$ V/m. The average air speed inside the tornado is $v = bE \approx 2{\cdot}10^{-4}\times 2{\cdot}10^5 = 40$ m/s. In reality the speed may be same or more in less voltage because the voltage (acceleration) is acting long time.

d) Magnetic Field

The electric currency flowing along the tornado produces the circular magnetic field around tornado, which also may influence in the tornado stability. This influence may be estimated by equations:

$$H = \frac{i}{2\pi r}, \quad p_m = \frac{\mu_0 H^2}{2}, \quad B = \mu_0 H, \quad \mu_0 = 4\pi 10^{-7} \ [H/m], \qquad (10)$$

$$r_e = \frac{V_e}{(q/m)B}, \quad or \quad r_e = \left(\frac{2}{q/m}\right)^{1/2} \frac{U^{1/2}}{B}, \quad T = \frac{2\pi}{(q/m)B}, \qquad (11)$$

Where H is magnetic intensity A·m; pm is pressure, N/m2; B is magnetic intensity in T; q is charge of particles, C; Ve is speed charged particles. m/s; re is moving speed of particles, m/s; m is mass of charged particles, kg; U is energy of the charged particles in eV; T is rotated period of the charged particles, sec. Motion of the charged particles is perpendicular to magnetic lines.

IV. Protection from Tornado

Using the offered theory the author offers a method of protection from tornado. If we temporarily can break the stability of the tornado, we can destroy the tornado. To do this we must deprive the energy of the tornado pump. It is possible, if the time, when the tornado pump cannot work, will be enough for its distraction. The easiest way is a connection the tornado cloud (funnel) to ground. If we fence the important object (military base, nuclear station, village, etc.) by row of small balloons (better wing dirigibles (fig. 5)) good connected by the conductivity wire to ground, the electric currency will flows directly to ground and will not pumps the air from tornado.

For good contact with cloud the entire surface of dirigible (air ballroom) must have the conductive layer and the lower end of wire should be buried into a moist ground (fig. 5a). Distance between dirigibles is about 150 – 200 m, altitude 200 – 250 m.

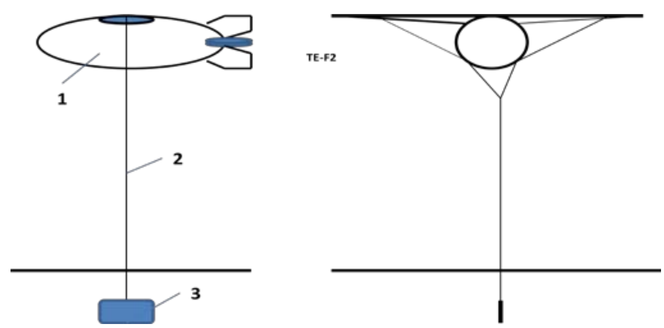

Figure 5 : Protection against tornado. *Notations* : 1 – wing dirigible covered by conductivity layer; 2 – wire; 3 – grounding lightning rod

It is easy to build a small model of check up the theory and protection method.

V. Note about Hurricane

The hurricane is gigantic vortex (fig.6) typically having diameter 300 and more km. Photo of hurricane from out space is shown in fig.3. Into center the hurricane has a calm area having the diameter about 50 - 60 km. That area is named "Eye". "Eye" has "Eyewall" having the thickness about 40-50 km.

At the center of a mature tropical cyclone, air sinks rather than rises. For a sufficiently strong storm, air may sink over a layer deep enough to suppress cloud formation, thereby creating a clear "eye". Weather in the eye is normally calm and free of clouds, although the sea may be extremely violent.

The cloudy outer edge of the eye is called the "eyewall". The eyewall is where the greatest wind speeds are found, air rises most rapidly, clouds reach to their highest altitude, and precipitation is the heaviest. The heaviest wind damage occurs where a tropical cyclone's eyewall passes over land.

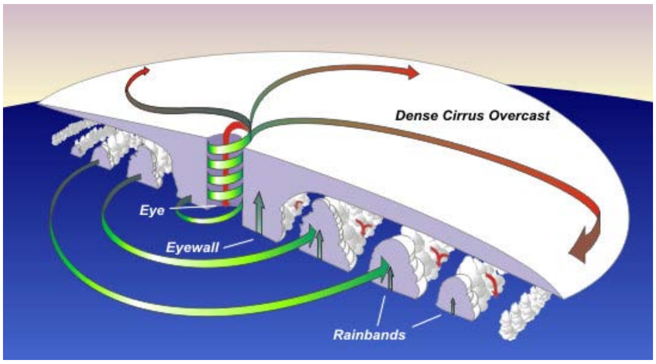

Figure 6 : Scheme of Hurricane

The static electricity produces the strong vertical air flows. The including them into the hurricane theory allow more exactly compute the hurricane.

VI. Summary

The author proposes a new theory of the tornado stability. He shows: the high electric voltage between clouds and ground surface produces the intensive electron/ion flow into tornado. That flow creates the air stream which sucks off (pumping) air from the inside tornado channel and make the tornado stability.

If we want to destroy the tornado stability we must decrease the electric intensity into the tornado channel. The simplest method is connection by a conductive wire the funnel of tornado with ground.

For this the top end of fire must has a large conductive area (air ballroom or wing dirigible with conductive layer), the lower end of wire must has the good contact with wet ground.

The row from these conductive wires having step 150 – 200 m and altitude 200 – 300 m allows protecting from tornado the villages, towns and important objects as the nuclear electric station and military bases.

The research papers relating to this topic are presented in [1]-[17].

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High Temperature Adhesive: Eccobond-104

By Prof. D. V. Mahindru and Prof. Priyanka Mahendru
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Abstract- Eccobond 104, a high temperature epoxide adhesive is used for bonding porous/nonporous materials. e.g. 1. Metals preferably Aluminium,Carbon Steel, Stainless steel, brass carbon steel, 2. Ceramics, 3. Plastics, 4. Metalized carbon to steel, 5. PTFE, 6. Glass, 7. Thermo set.

Various process shops have dealt with the properties, preparation, application, curing and inspection of Eccobond 104A/104B. The present paper takes in to count various requirements of preparation,application, curing and testing of the adhesive. In the present study, which is based upon Various practices followed by different organizations in the world and author's own experience of working with this high temperature adhesive. After curing the adhesive retains good strength up to 220deg C. The shear strength is found to be :

- 17.4 MP_a at 24 deg C.
- 12.5 MP_a at 150 deg C.
- 7 MP_a at 230 deg C.
- (1 MP_a =145psi).

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HIGHTEMPERATUREADHESIVEECCOBOND-104

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Prof. D. V. Mahindru [α] & Prof. Priyanka Mahendru [σ]

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I. Introduction

Eccobond 104 is supplied in two parts, part A is liquid and part B is fine powder . This is supplied in sealed container having not more than 1 litre and 1 kg of part 'A' and part 'B' respectively. Part "A" is liquid and is available in three viscosities:

Standard Grade : 30,000 to 40,000 cps.

Filled Grade : 50,000 to 60,000 cps.

Putty Grade : 750,000 to 85,000 cps.

Unless otherwise stated, standard grade part 'A' is to be used for all applications. In sealed containers, under dry conditions, the shelf life is 2 years. However the shelf life for the materials unopened, is indefinite provided the materials pass the laid down tests. This is a high temperature adhesive that retains good strength up to temperature of 220 deg C. The paper deals with application of this adhesive with particular reference to wide range of material that are frequently required to be bonded and thereafter are required to work under high temperature going up to 220 deg C. The paper explains in detail the methodology to be used for Preparation, Application, Curing, Handling and Inspection of test piece. This is lucid and handy document useful for all practicing Engineers technologists and industries where bonding of high temperature adhesive is a frequent requirement.

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II. Preparation

a) Batching

The following procedure and precautions are required to be taken while doing the batching.

i. The liquid must be taken from a container which has been stirred to counteract "layering".
ii. The powder must be taken from its container under dry conditions because it is highly hygroscopic and will deteriorate.
iii. The mix ratio by weight is to be:
   - 64 parts of part "B"
   - 100 parts of liquid "A"
iv. The quantities sufficient for normal work load batches, should be repacked in new containers, preferably not less than 39 gms of part "A" and 25 gms of part "B"in order to ensure proper proportioning.
v. The screw top glass bottle for the powder should be of size that will hold 25 to 40 gms when completely filled. The container for the liquid must be of such a size that will be $1/3^{rd}$ full when it contains the exact amount of part "A", necessary for correct mixing ratio.
vi. Each item is to be sealed, dated and identified including co-relation of paired container.
vii. From each new incoming batch of materials, a sample is to be mixed and used for testing as per the prescribed procedure.

b) Mixing

Mix thoroughly to a smooth flowing consistency. Care is to be taken to ensure that whole bottle of powder is added to the associated liquid and none is lost. It may be noted that finely divided powder is easily blown about. Warm the mixture to 60 deg C (approx) to improve the flow characteristics.

Stages	Key Points
Thoroughly part "A" resin before using.	It is important to invert the tins Containing part "A" occasionally to ensure that resin does not settle too much.
Weight out 100±1/2 parts "A", 64 ±1/2 parts of part "B"	
Warm the mixture to 60deg C to help mixing.	
Mix thoroughly the two parts Ensuring that all particles of Powder are mixed mixed with Resin. (Eccobond 104 "B" should be sieved to separate the lumps of powder)	It is preferable to use disposable un waxed cups and wooden Spoon. Mix together to smooth consistency.
When mixed and while still warm, De-aerate by placing in a vacuum oven of 2 mm Hg or less.	This is best carried out in vacuum oven held at 60 deg C.
The mix will initially froth, and space must be allowed in the mixing cups, but after a few minutes the froth will collapse.	The mix should be held in vacuum for 30 min after collapse to ensure complete de-aerate. This mixture should be de-aerated after every 6 hrs.

c) *Pot Life*

24 hours minimum at 25 deg C. This time will be reduced at higher temperature.

d) *Surface Preparation*

This is carried out to produce a satisfactory adhesive bond.

i. The bonding should be carried out within 24 hours of surface preparation. Where this is impracticable, an additional degreasing operation immediately prior to bonding shall be carried out. The degreasing is to be done as per the process detailed for the appropriate material. If nothing is quoted, degrease process shall be ;

Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

e) *Operating Procedure- Metals and Alloys*

i. *Aluminium and Al. Alloys*

Method - 1

a) *Degrease with trichloroethylene vapor as per the following sequence*

i) Immerse components slowly in vapour compartment(not in boiling Liquor)

ii) Leave for 1-5 minutes according to weight of the components. A heavy component will require a longer time to attain the same temperature as the vapor, this is essential for complete degreasing.

iii) Withdraw slowly.

b) *Alternatively*

Where vapor degreasing is impracticable, degreasing using clean liquid trichloroethylene is permissible.

1. *Abrade the surface with wet stone.*
2. Degrease with trichloroethylene vapor as per para a) above.

Method - 2

a) Dry Hone.

Method - 3

a) Chromate film to be given as per the approved method.

Method - 4

This method is used for all aircraft structures and components where corrosion protection is required. Anodise to appropriate chromic acid method of anodizing viz DEF- 151 Type-2.

Note : The bonding should be carried out within 16 hours of anodizing if practicable. If for any reason it is practically not feasible to complete the bonding process within 16 hours, then the surfaces should be reactivated as per the following scheme.

a) *Scheme for Reactivation of Sealed/ Contaminated Anodic Surfaces*

This scheme covers the application of acid based solution for the reactivation of anodized surfaces which have become sealed contaminated.

i. *Approved Solutions*

- Ardrox 1074 supplied by M/s Ardrox Ltd., Brentford Middlesex, U.K.
- Metal 'Prep' which shall have the following formulations and shall be prepared by the material lab.

Phosphoric Acid (85%)	35 ml
Teepol	05 ml
Butul Cellosolve	62.5 ml.
Water	147.5 ml

For bonding purposes, the preferred solution for reactivation is Metal 'Prep' as above.

Process

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
- Scrub the surface to be reactivated, with a clean cheese cloth charged with the reactvation solution. The surface must remain wet for 1 to 2 minutes before wiping dry with a clean cheese cloth. If the solution has dried, make a fresh application and wipe off immediately.
- If the cheese cloth shows signs of contamination, re- prepare the surface as above using reactivation solution diluted with the equal volume of water. Repeat until a clean wipe is obtained.
- Wash the surface using a clean cheese cloth and warm distilled de-ionized water until testing with blue litmus paper indicates no acid is present. If the litmus paper turns red, the acid is present, and further swilling is required.

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- At this stage, the surface should be covered with a uniform film of water, i the water breaks occur, this indicates that the reactivation is not complete and the process must be repeated as above.
- Before bonding,, the component must be either
  1. Over dried 10 to 20 minutes at 55 deg C to 65 deg C and cooled to below 30 deg C.
  2. Wipe with a mixture of equal volume of Industrial Methylated Spirit (IMS) or deionised water and allowed to dry at room temperature for 30 minutes.
  3. Bonding must commence within 8 hours.
- Where the anodic surface to be reactivated has been locally repaired with alochrom solution, application of reactivation solution must be continued until the alochrom treatment has been removed i.e. ll traces of alochrom treatment has been removed. Such areas may then be retreated with alochrom but without rescuffing the surface. In such case, the bonding and painting shall commenc within i hour.
- Cheese cloth must not be redipped in reactivation solution of swill water, a new cloth must be used every time.
- Care must be taken to avoid flooding the surface with reactivation solution or swill water to ensure that none is trapped in crevices or other parts of the component.
- Operator shall wear rubber gloves to prevent reactivation solution contact with skin.
  a. *If the assembly contains components which are to be machined after bonding, the same may be allowed, Masking of the bonded areas, before chromic acid anodizing is not required.*

f) Copper and Copper Alloys

Prepare the surface with following method

- *Method*
- *Degrease with trichloroethylene vapor as per the following sequence*
  (a) Immerse components slowly in vapour compartment(not in boiling Liquor)
  (b) Leave for 1-5 minutes according to weight of the components. A heavy component will require a longer time to attain the same temperature as the vapor, this is essential for complete degreasing.
  (c) Withdraw slowly.
- *Alternatively*

(i) Where vapor degreasing is impracticable, degreasing using clean liquid trichloroethylene is permissible.

(ii) Abrade the surface with wet stone.

(iii) degrease with trichloroethylene vapor as per clause (i) above.

- Etch at room temperature for 5 minutes with neutraclean 68 diluted 2:1 by volume with distilled water. The solution must be stirred throughout the etching process.
- Rinse thoroughly with cold tap water.
- Dry using clean kim-wipe hot air circulating oven or hand air drier.
- Apply a thin film of DZ-80 to the surfaces, which are to be bonded and dry for 30 minutes at 80 deg C+5 deg C.
- Allow to cool and abrade with 320 grade silicon carbide paper wet or dry Tri-Mite untill the surface is matt.
- Wipe with kimwipe soaked in IMS to remove traces of abrasive.
- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

g) Iron and Ferrous Alloys (Except Corrosion resis Steels) and laminations

- *Method - 1*
- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
- Etch at room temperature with ferric chloride solution for 10 seconds.
- Rinse in cold tap water.
- Wipe, while wet, with damp cotton wool to remove any residue.
- Dry using clean kimwipe, hot air circulating oven or hand hair drier.
- Caution : Where rusting may occur e.g. mild steel parts, hot air drying should not be used.
- *Method - 2*

a) Flash nickel plate as per the appropriate standard and treat as follows

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
- Surfaces may be bonded up to 2 weeks after plating.

h) Steel, Corrosion Resistant

- *Method*
- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
- Etch at room temperature with ferric chloride solution for 2 minutes.
- Rinse in cold water.
- Wipe, while wet , with damp cotton wool to remove any residue.
- Dry using clean kim wipe, hot air circulating oven or hand air drier.

i) Cadmium, Passivated and Unpassivated

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

Surfaces may be bonded within 2 months after plating.

j) Nickel

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

- Surfaces may be bonded within 2 weeks after plating.

i. *Silver*

Method - 1

- Apply Argentoplatine with distilled or demineralized water.
- Rinse in cold distilled or demineralised water. And stove dry at 100 deg C.

Method - 2

Where ultimate strength is required:

- Passivate to appropriate specification.
- This method has minimum effect on contact resistance.
- Surfaces may be bonded within 24hours of surface preparation.

k) *Surfaces which are Tin plated*

- Metal (Tin) not suitable for adhesion.
- Locally remove the plating if plated.
- After removal Tin plating from the base metal, the surfaces may be prepared as per the method laid down for the base metal.

l) *Magnetic Materials*

- Dry hone or vapor blast.
- Vapor blast to appropriate spec.
- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

m) *Glass/ Plastics*

a. *Glass*

- *Grind or short blast surface.*
- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

b. *Delran (Polyacetal)*

1. Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
2. Etch at 100 deg C for i minute in the following solution. Ensure that the components are at 100 deg C before immersion.
3. 0.3 gm Toluene P-Sulphuric acid.
4. 150 cm^3 Per chloroethlene.
5. 3 cm^3 1.4 Dixon.
6. Remove the components from hot solution and immediately heat the wet components for 3 minutes at 100 deg C.
7. Rinse thoroughly in warm water.
8. Dry using kimwipe, hot air circulating oven or hand hair drier.

Notes:

- This process should be carried out in a well ventilated area, where means of extraction are available for any health hazard.
- During operations (2), the apparatus should be designed with vapor cooling ring., as due to evaporation a concentrated solution will result. Stainless steel solution is suitable material for the cooling ring.

c. *Etched Maline*

Method

Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

d. *Nylon*

Method

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
- Abrade the surface with 240-320 grade silicon carbide paper wet or dryTri-M-ite or vapour blast as per the appropriate spec.
- Wipe off the residue from abrasion with damp cotton wool.
- Dry, using clean kimwipe, air circulated oven set at 70 deg C or hand hair drier.
- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

e. *Fluoro Plastics (P.T.F.E., F.E.P. etc), if not pre-etched*

Method

General method where ultimate adhesion is not required, i.e. where mechanical fasteings provide the main strength.

- Allow the tetra etch solution to reach room temp.
- Apply tetra-etch solution by dipping or liberally brushing the surfaces to be bonded.
- When the surfaces become milk chocolate brown in colour (approx 5 seconds), remove the tetra etch by wiping with clean cloth soaked in I.M.S.
- Ensure that the bottle of tetra-etch solution has been kept tightly closed and stored at -10deC to 0 deg C. It must not be left at room temp aftwer use.
- Ensure that the bottle has been in use for less than six months. Record the date on the bottle when it is initially opened.
- The bottle must be atleast one third full. Bottles which are partially used can be combined provided neither has been used for more than 4 months. Pour the newer solution in the older dated bottle.

Caution

The above precautions to remove moist air are necessary because this solution reacts with water very readily ceases to be capable of etching.

f. Resin Bonded Board

Method

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
- Abrade the surface with one of the following methods
- 240-320 grade silicone carbide paper (Wet or dry Tri-M-Ite).
- Vapour blast to appropriate Spec.
- Wash off the residue from abrasion in cold water.
- Dry, using kimwipe, air circulating oven at 70 deg C or hand hair drier.

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

g. *Silicone Resin Bonded Glass Board*

This surface is unsuitable for adhesion.

h. *Thermoset Mouldings*

- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)
- Abrade the surface with one of the following methods:
- 240-320 grade silicone carbide paper (Wet or dry Tri-M-Ite).
- Vapour blast to appropriate Spec.
- Wash off the residue from abrasion in cold water.
- Dry, using kimwipe, air circulating oven at 70 deg C or hand hair drier.
- Degrease surfaces to be reactivated as per Para e) Method-1 clause a)

i. *Rubbers Natural, Nitrile, Neoprene (Excluding Silicone Rubber)*

- *Method*
- Carefully place in concentrated sulphuric acid at 20 deg C to 25 deg C for the following period of time.

Natural rubber	: 1 minute
Nit rile Rubber	: 2 minutes
Neoprene Rubber	: 5 minutes

Ensure that the surface to be treated is in contact with acid.

- *Caution*

Silicone rubber is not suitable for bonding with epoxy adhesive.

n) Painted Surfaces

Wipe the surfaces which are to be bonded with clean cloth soaked in SBP. Care must be taken to ensure that the surfaces which are not to be bonded should not be wiped.

i. *Carbon*

Abrade with 120 grit emery paper and ultrasonically clean to appropriate spec.

a. Ultrasonic Cleaning

This method specifies requirements for cleaning components with ultrasonic equipment which is designed for process where;

- The components are immersed in a tank containing a transmission fluid of either water or kerosene.
- The container is partly immersed in tank containing a transmission fluid of either water or kerosene.
- This method is not suitable for Rubber/-Seals/Bellows/Bellow Assys/Impregnated electrical coil.

b. Abrading of bonded threads is not required. Surfaces 32 micro inches or inner surfaces,sharo edges must be protected against abrasion. Ensure complete freedom from abrasive particles before bonding.

c. Absolute freedom from grease and finger marks is essential. Check wetability with distilled water, dry off and clean with solvent. Do not touch. Clean with cold solvents as per appropriate spec.

d. For adhesive mixture used in every batch of parts being bonded, test piece is to be prepared, processed and tested as follows:

- The test piece to consist of two strips of steel each 11/12 cm long,24.6/26.2 cm wide X 0.85/1.3 cm thick. The edges must be free from burrs.
- The surfaces to be bonded are to be prepared by abrasive blasting, using aluminum oxide grit, 120/220 mesh to produce a finish not finer than 120 micri inch.
- Clean to ensure that the surfaces are free from grease and finger mark. This may be carried out by cleaning with cold solvents as per the appropriate standard.

1. Rubber seals should be cleaned with Kerosene and not subjected to any other solvent.
2. Bellows and bellow assy's be cleaned with Kerosene nd not subjected to any other solvent.
3. Cleaning must be carried out immediately prior to bonding.

- With the aid of suitable fixture, bond with an overlap of 12.7/14.3 cms and the long edges parallel following the procedure as laid down in para 4 of this paper.
- When pulled on testing machine at a rate of loadin of 1.3/2.7 KN per minut, the joint is to withstand a load of 4.5 KN (1000 lbf.) without failure.
- Pulling of test piece shall be carried out by Physical testing lab under the supervision of quality control deptt.

III. Application

- The adhesive will normally be applied to both contacting surfaces. However there will be cases such as plugging of blind holes where to avoid entrapment of air, an adequate pool of adhesive is to be applied to the hole only and excess is exuded by carefully pressing the plug to bottom. Preferred thickness of the layer of the adhesive is between 0.5 to 1.5 mm depending upon the requirement.
- Assemble cylindrical parts with a twisting motion, if possible, to ensure joint coverage. Suitable fixtures must be used to ensure that the position of the parts is not disturbed. Viz mandrels, rods with spring loaded washers.
- With flat surfaces, bring the surfaces together and loghtly squeeze out excess material.
- After mating the parts, carefully wipe away excess adhesive preferably with cotton buds.
- Place in cool oven (50 deg C max.). Cylindrical joints should be arranged to be vertical so that

surface tension will help the assembly to maintain concentricity and equalise the joint thickness. Flat joints to be arranged such as to maintain the parts in their relative positions but no pressure is to be applied except only light clamping.

IV. Curing

- Curing may be accomplished in accordance we on of the following schedules.

Time (Minimum)	Temperature
6 hours	120 $\pm$ 5 deg C
3 hours	150 $\pm$ 5 deg C
2 hours	180 $\pm$ 5 deg C
1 hours	200 $\pm$ 5 deg C

- General guide lines for curing different materials are as follows:

1. Steel, Nickel, Copper	:1 hour	190/200 deg C.
2. Alloys or carbon.	:2 hours	175/185 deg C.
3. Al Alloys	:4 hours	150/160 deg C.
4. Assy's Containing Rubber and plastics	:Refer Drawing of the component/ Assy.	

- If the assembly is to be used at temp. Above 250 deg C, it shall be given a further cure of 12 hrs. (min) at 260 deg C.
- *Eccobond may break at 400 deg C. At this temp. It can cause distortion and change of properties. So, care must be taken for all these factors.*

V. Handling Precautions

- Avoid skin contact and inhalation of vapours. The use of barrier cream is recommended.
- Working area must be well ventilated and ovens extracted to outside atmosphere.

VI. Inspection

a) *Material Control*

i. When received, the parts 'A' and 'B' shall be passed through "Quarantine Inspection Deptt" to the laboratory. The laboratory shall repack the material as per para II. Preparatrion a) Batching

ii. Identification of contents and correlation of paired containers to para II. Preparation a) Batching Para iv, v and vi must be clearly visible on each jar. Where the identification label is missing from a jar or not legible or the seal is broken, the contents must not be used.

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Investigating the Effect of Defects through Non- Radiative Recombination Centres in a Single Emitter Laser Bar using a Laser Diode Simulation/Emulation Tool

By Christian Kwaku Amuzuvi & Philip Blewushie
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Abstract- This paper further explores the capability and versatility of Barlase in establishing deeper understanding of an emitter in a laser bar. There is communication between an emitter and the substrate on which it is mounted and this is linked to the degradation process that occurs in lasers. It is well known that various factors come into play in the operation of individual emitters and full laser bars (L-I characteristics, threshold, efficiency, etc.) but one of the most important is the effect of introducing defects through non-radiative recombination centres. Barlase is therefore used to investigate the effect of defects based on the Arrhenius equation, where the quantum well trap generation rate is activated by the local quantum well temperature. The trap generation rate is multiplied by the aging time and the trap density is updated at each aging step. Barlase allows a better understanding of how current competition, temperature and the level of defects affect the output power and the degradation rate of the bar. The significance of this study is to investigate the effect of defects through non-radiative recombination centres in a single emitter laser bar. This was done in order to establish a fair idea of how single emitters will operate in the context of a multi-emitter laser bar through the introduction of non-radiative recombination centres.

Keywords: by-emitter, emitter, quantum well, defect, non-radiative recombination, degradation, temperature, threshold current, slope efficiency, band gap energy.

GJRE-F Classification : FOR Code: 020502

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Christian Kwaku Amuzuvi [α σ] & Philip Blewushie [α]

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Keywords: by-emitter, emitter, quantum well, defect, non-radiative recombination, degradation, temperature, threshold current, slope efficiency, band gap energy.

I. Introduction

High power semiconductor laser diodes have occupied the minds of researchers in the last decade due to their emerging widespread usage in the fields of medicine, industry and in consumer products like laser printers and others [1-2].

The effectiveness of *Barlase* has already been demonstrated using hypothetical laser bars and published elsewhere [3]. In this paper however, *Barlase* is being used to simulate/emulate degradation processes using a hypothetical single emitter high power laser bar considering defects through non-radiative recombination centres. This paper gives a further impetus to the by-emitter degradation analysis technique developed over recent years [4-8].

This tool is also an addition to the by-emitter analysis technique where the effects of certain factors that affect the degradation of laser emitters/bars can be investigated. The objective of this study is to investigate and analyse the effect of the existence of defects through non-radiative recombination centres in a single emitter laser bar.

II. Materials and Methods

The standard test structure selected is one employed in the experimental work in a task published elsewhere [9]. This structure was selected bearing in mind the fact that an attempt will be made to further emulate the degradation of bars made from "the same epitaxial" structure with similar dimensions. The structure used was the 975 nm narrow-angle (<1°) tapered laser from Alcatel Thales III-V Lab. The total length was 2.4 mm, consisting of a 200 μm ridge waveguide and a 2200 μm tapered amplifier. The front and rear facet reflectivities were 3% and 90%, respectively. The 'standard' simulation of this structure assumes a heatsink temperature of 300 K and a trap density in the QW of 2×10^{15} cm^{-3} [10]. All of the simulations in this paper use this structure and the results are referenced to this 'standard' structure. Figure 1 shows the laser structure.

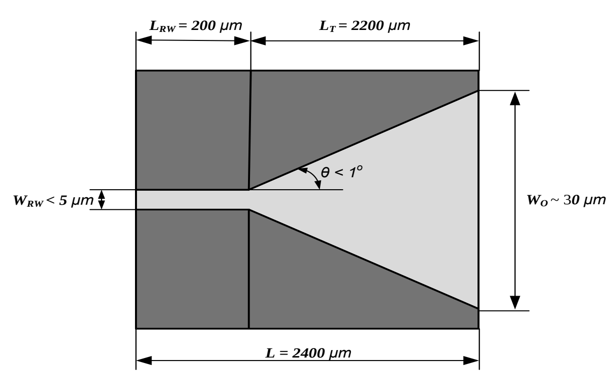

Figure 1 (a) : Hypothetical standard 975 nm tapered laser structure

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Simulations were performed considering the effect of introducing defects through non-radiative recombination centres introduced into the quantum well of the single emitter bar. The data obtained from these single emitter simulations were performed in the constant current mode of operation [9].

III. Results

To investigate the effect of defects, simulations were performed with different levels of non-radiative recombination in the QW. Simulations were carried out for QW trap densities, N_t, of 2, 4, 10, 20 and 100 times the standard value, $N_t = 2\times10^{15}$cm^{-3}.

Figure 2 shows the power-current characteristics and the evolution of the maximum QW temperature with bias current for each of the trap densities investigated. The P-I curves for the different trap densities show how an increase in trap density increases the threshold current and reduces the output power. Figure 2 also shows how the maximum QW temperature increases with trap density and current.

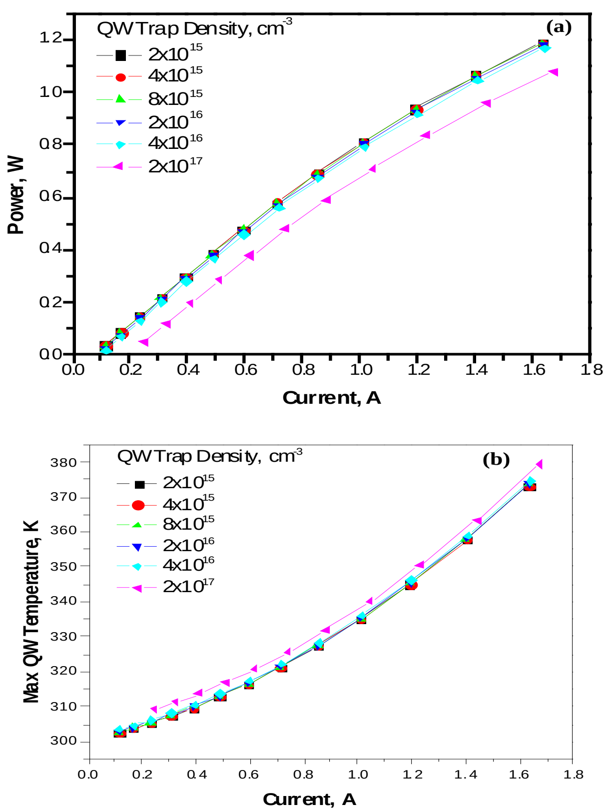


Figure 2 : (a) Power-current characteristics and (b) the maximum temperature in the QW as a function of current for simulations with different QW trap densities

Figures 3 and 4 shows the equivalent power-voltage/current-voltage characteristics and the evolution of the maximum QW temperature with bias current for each of the trap densities investigated.

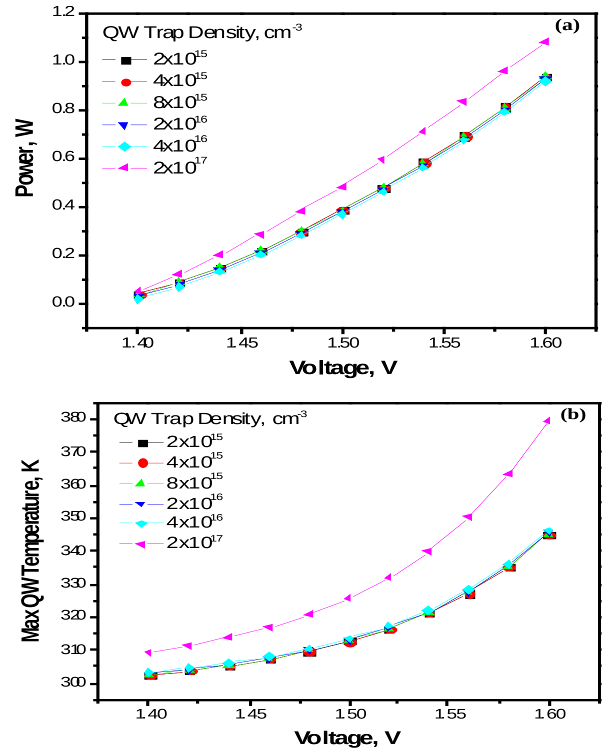


Figure 3 : (a) Power-voltage characteristics and (b) the maximum temperature in the QW as a function of voltage for simulations with different QW trap densities

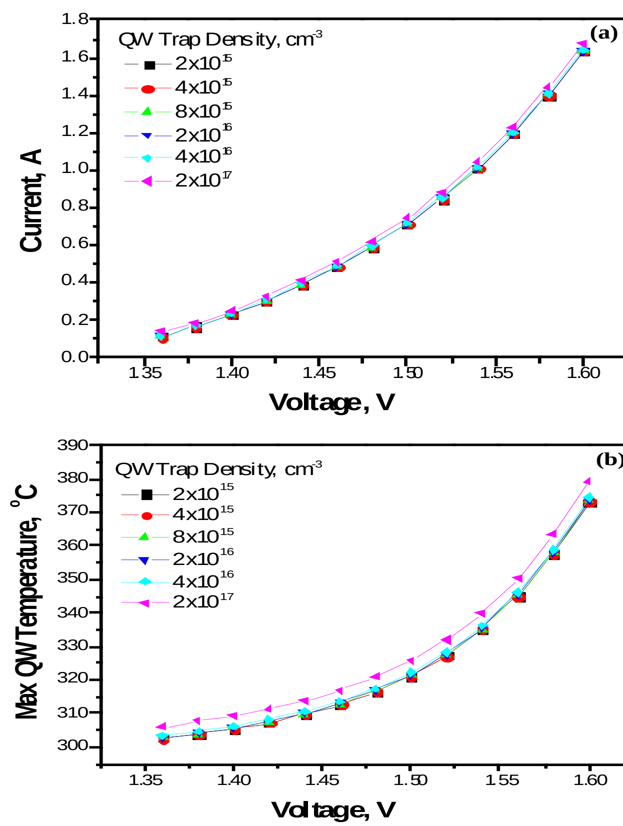


Figure 4 : (a) Current-voltage characteristics and (b) The maximum temperature in the QW as a function of voltage for simulations with different QW trap densities

The threshold current and slope efficiency have been extracted from the P-I curves in Figure 2 and plotted as a function of trap density in Figure 5. For moderate trap densities (N_t up to 2×10^{16} cm^{-3}), the threshold current increases by around 10-15%. At much higher trap densities (N_t up to 2×10^{17} cm^{-3}), the threshold current can more than double. Similarly, at moderate trap densities, the decrease in slope efficiency is less than 1%, but at higher trap densities this reduction can be as large as 5%.

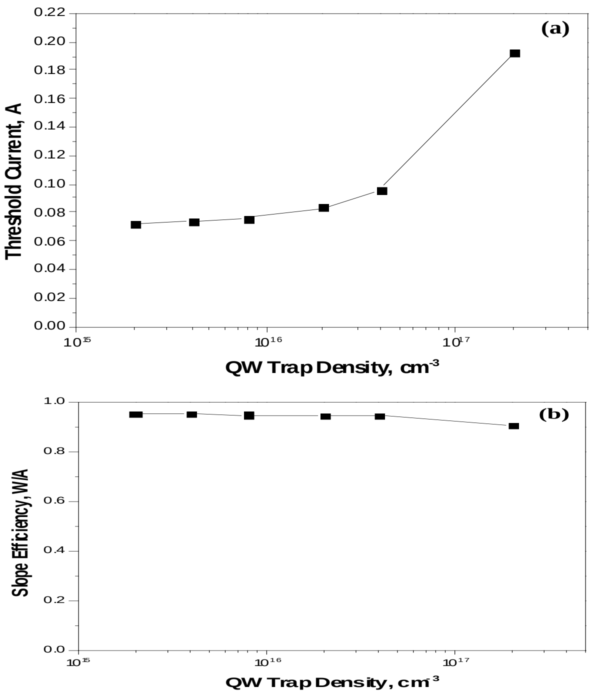
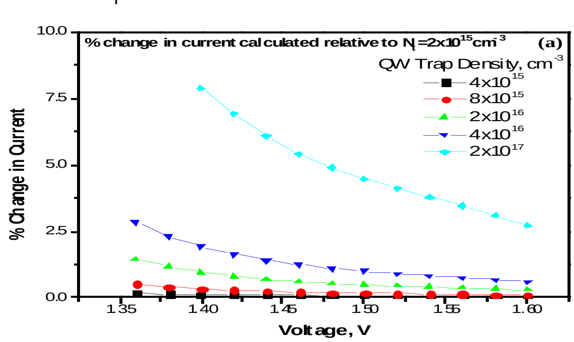


Figure 5 : (a) Dependence of threshold current and (b) Efficiency (right) on QW trap density

To see the differences in the simulations, the percentage change (relative to the case with $N_t = 2\times10^{15}$cm^{-3}) in both bias current and output power are shown in Figure 6. These results are plotted for different bias voltages, as the bias voltage is common to all emitters in the laser bar. The percentage change in current for a given voltage is smaller than the percentage change in output power at the same voltage. This may help to explain why simulations converged faster for the constant current mode than for the constant power mode.



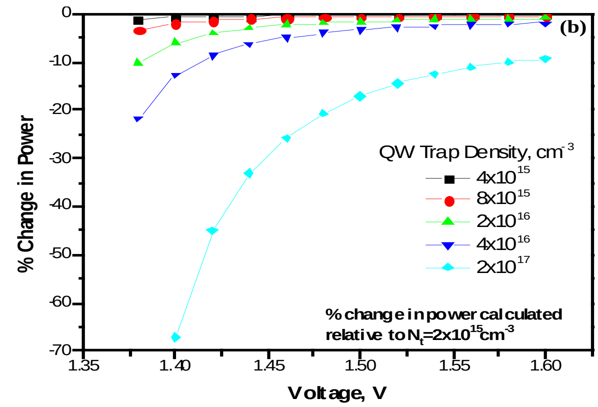
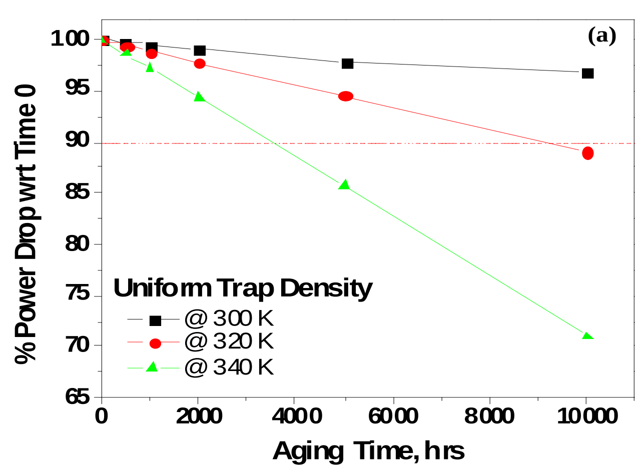


Figure 6 : (a) Percentage change in current and (b) Power in simulations at different QW trap densities relative to the standard QW trap density of 2×10^{15}cm^{-3}

In Figure 6, at a voltage of 1.50 V (this is around the probable operating point of this device, i.e. the device is lasing well above the threshold, but has not reached the thermal roll-over point), the current increases by up to 1% for moderate trap densities with up to a 4% reduction in power. For higher trap densities, the current increase is of the order of 5% with the power reduction reaching nearly 20%. *Barlase* was enhanced to allow for a spatially variable trap density distribution and hence a more realistic trap density distribution was attained [9].

The trap density distribution, generated as a function of QW temperature distribution in this case allows for a more realistic and accurate simulation of the degradation behaviour (Figure 7b), which the earlier case (Figure 7a) had overestimated. The increased degradation rate observed at higher temperatures in Figure 7a was as expected. The degradation rate is slower with the local trap model (Figure 7b) with a device surviving 10,000 hrs of aging at both 300 K and 320 K. However, a device losses more than 10% power after ~7,000 hrs at 340 K.



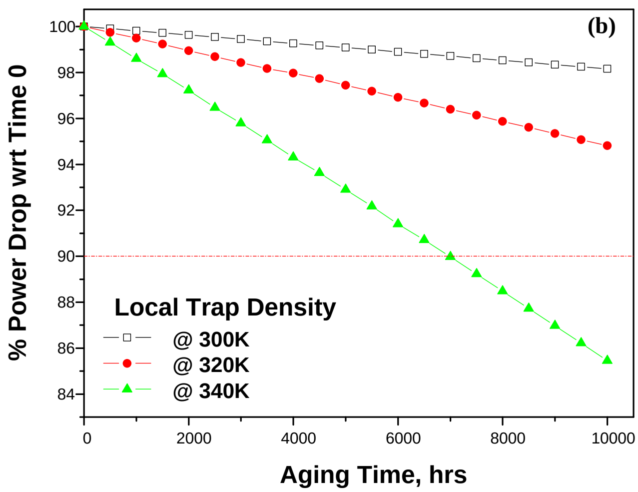


Figure 7 : Graphs of (a) Emitter power and (b) % Power drop against aging time

IV. Discussion

The principal factors that affect laser degradation are defects (both point defects and line defects), temperature, packaging-induced strain, and inhomogeneous heatsinking (e.g. solder voids, solder flow, etc.). To understand how each of these factors affects the operation and degradation of a laser, a number of simulations were performed using a single emitter bar. In this paper, the investigation was done considering the effect of the introduction of defects through non-radiative recombination centres independently. The simulations were performed for a constant bias voltage, as this is the common factor between individual emitters once they are part of a laser bar. In all cases, simulations were attempted at voltages ranging from 1.32 V to 1.60 V at intervals of 0.02 V. Majority of these simulations converged within 10 – 15 round trips.

V. Conclusion

We have shown in this paper that, even simulations of single emitters can provide a great deal of insight into how emitters will operate in the context of a laser bar. However, it is important to consider their operation with respect to a fixed bias voltage and not with respect to a fixed bias current. The factor investigated here (i.e., defect density through non-radiative recombination) can affect the operation of an emitter. That notwithstanding, it is high levels of defects can play a significant role in the degradation of emitters. It is known that low levels of defects and packaging-induced strain have low effects on laser degradation, but these are nonetheless important when combined with all other factors that can affect laser degradation. The limitation of this study is that the research work is ongoing and more work needs to be done to improve upon the simulation tool to include a global thermal solver.

VI. Acknowledgement

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Design and Implementation of a "MIMO Smart Antenna": A Candidate for "Green Technology"

By Neeraj Kumar, A. K. Thakur & Arvind Kumar
Amity University, India

Abstract- In this paper, Dielectric-Loaded Microstrip Patch Antenna (DL-MPA), has been synthesized and analyzed, which is also referred as "MIMO Smart Antenna" In the designing procedure, three different antennas are designed and simulated. Firstly, "Antenna 1" is a RDRA (Rectangular Dielectric Resonator Antenna) which has been simulated using only one probe coaxial feed technique. Secondly, "Antenna 2" RDRA has been simulated using multiple ports, in addition to the previous excitation it has been excited using other two, strip feed coaxial probe ports. At last, bandwidth improvement method has been implemented to a MPA, and multi frequency operability has been obtained, referred as "Antenna 3". Experimental approach has been implemented to support antenna analysis and obtained simulated results. Antenna parameters such as return loss, VSWR plot and EH field has been plotted and studied to obtain characteristics performance of the radiating structure. Antenna offers operability at frequency range of 1.5GHz, 3.32GHz and 4.14GHz and having return loss of -21.82dB, -17.48 dB and - 36.32dB respectively, and radiation efficiency of the system ranges from 99-135%. These results verify the use of proposed antenna in different frequency of operation; The obtained performance of proposed design, confirms the practicability of antenna in different indoor/outdoor wireless applications. Suitability and applicability of antenna has been found in GSM and other wireless systems frequency range.

Keywords: dielectric resonator, microstrip patch antenna, MIMO, smart antenna, co-axial probe, return loss, VSWR, resonating frequency, multiple ports, gsm application.

GJRE-F Classification : FOR Code: 100501

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Keywords: dielectric resonator, microstrip patch antenna, MIMO, smart antenna, co-axial probe, return loss, VSWR, resonating frequency, multiple ports, gsm application.

I. Introduction

Antenna, important from point of view of research and because of growing demand of bandwidth, frequency of operability and capable to support high data rate and throughput.

a) MIMO Antenna

Multiple Input Multiple Output is MIMO technology which is gaining popularity in field of antennas because of its improved performance. Antenna is being widely accepted for emerging technologies, LTE and for applications which requires multiple frequency applicability. Both at the transmitter and the receiver end multiple radiating structures are used and performance of system is increased by minimizing the error and optimizing the system. It gives significant increase in link range and in data throughout. MIMO system is also useful in cell phone networks to meet the growing demands of the subscribers. It is useful for providing high end services such as video conferencing and for high speed mobile internet. MIMO is one of the several forms of smart Technology. It does not require additional band width or additional transmit power. It offers higher spectral efficiency.

b) Smart Antenna

Receiving and transmission characteristics of antenna are adapted and modified accordingly, to minimize the error and thus enhance the performance of antenna. Smart antennas are important for reducing the deleterious effects of intentional jamming signals, unintentional co-channel interference, and multipath. These antennas were first known as "Side Lobe Cancellers", and then renamed as "Adaptive Antenna" and more recently, "Smart Antenna". Functioning of smart antenna rely on signal processing. Multiple antennas which are installed at transmitter and receiver end, transmit and receive signals. Amplitude and phase of signals are modified, in order to improve the reception of desired signal. To implement, smart antenna in communication system, must also rely on fact that the system should also be capable of holding it, so a smart system can have a smart antenna. On the other hand it should also be implemented such that cost of establishing the wireless network should be minimum, quality of service should also be better, realization of reconfigurable, robust, and transparent operation across multi-technology wireless networks.

c) Microstrip Patch Antenna

Micro-strip patch antenna is a simple and low profile antenna. It is conformable to planar and non-planar surfaces. The manufacturing of such antennas can be done at a very low cost using modern printed circuit technology, hence making it inexpensive. Micro-strip antennas are very versatile in terms of resonant frequency, polarization pattern and impedance. All this depends on the selection of patch shape and mode. These are mechanically robust when are placed on rigid surface. In order to create variations in the above mentioned resonant frequency, impedance and polarization pattern loads are added in between the patch and the ground plane.

d) Dielectric Resonator Antenna

These antennas are fulfilling the demand of higher bandwidth for video conferring, video call, IP TV

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and many other application which demands for higher bandwidth to support and efficiently manage the demands and growing need of customers. Hence, the antennas for modern wireless communication system should be low in profile and efficient in high frequencies. DRA are being considered because this material has many advantages in comparison to other. DRA offers many features such as small size, low cost, good bandwidth, high gain, Low ohmic loss and light weight. The DRA can be used at millimetre frequency bands and they are available in basic shapes such as rectangular, cylindrical, spherical and hemispherical geometries.

II. Theory

a) Calculation for MIcrostrip Patch

Dimension of the patch antenna for desired frequency, relative permitivity and substrate has been obtained using different conventional equations of the microstrip patch antenna systems. These equations are as follows:

$$W = \frac{c}{2f_0\sqrt{\frac{\epsilon_r+1}{2}}} \quad (1)$$

$$L = \frac{c}{2f_0\sqrt{\epsilon_{eff}}} - 2\Delta L \quad (2)$$

$$L_{eff} = L + 2\Delta L \quad (3)$$

$$\Delta L = 0.412\,h\left[\frac{(\epsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon_{eff}-0.258)\left(\frac{W}{h}+0.813\right)}\right] \quad (4)$$

$$\epsilon_{eff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left(1+12\frac{h}{W}\right)^{-\frac{1}{2}} \quad (5)$$

In these equations, f_0, c and h, are central resonant frequency, c is speed of light and h is the substrate thickness.

b) Calculation for RDRA

The RDRA is characterized by a height *h*, a width *w*, a depth *d*, and a dielectric constant ε_r, as shown in Fig. 1. The rectangular shape offers two degree of freedoms, making it the most versatile of the basic shapes. The ratios *w/h* and *w/d* can be chosen independently.

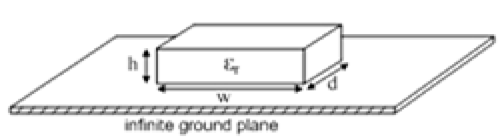


Figure 1 : A Rectangular Dielectric Resonator Antenna (RDRA)

The modes in an isolated rectangular dielectric guide can be divided into TE and TM, but with the DRA mounted on the ground plane, it is the TE modes which are typically excited.

For the $TE^{x}_{\delta 11}$ mode, the resonant frequency, f_0, is found by solving the following transcendental equation:

$$k_x \tan(k_x d/2) = \sqrt{(\varepsilon_r - 1)k_0^2 - k_x^2} \quad (1.1)$$

where,

$$k_x = \frac{2\pi}{\lambda_0} = \frac{2\pi f_0}{c}, k_y = \frac{\pi}{w}, k_z = \frac{\pi}{b}$$

and,

$$k_x^2 + k_y^2 + k_z^2 = {}_{r}k_0^2 \quad (1.2)$$

The following approximate equation has been derived for the normalized frequency F:

$$F = a_0 + a_1(w/b) + a_2(w/b)^2 \quad (1.3)$$

where

$$a_0 = 2.57 - 0.8(d/b) + 0.42(d/b)^2 - 0.05(d/b)^3 \quad (1.4)$$

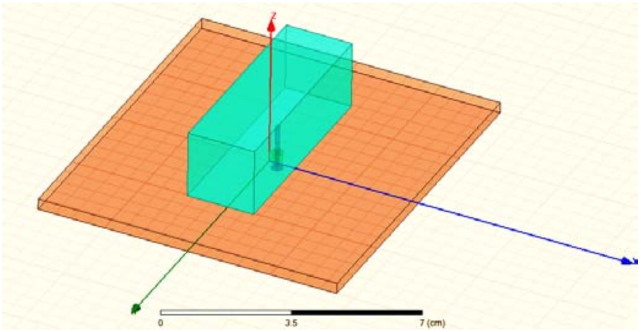
$$a_1 = 2.71(d/b)^{-0.282} \quad (1.5)$$

$$a_2 = 0.16 \quad (1.6)$$

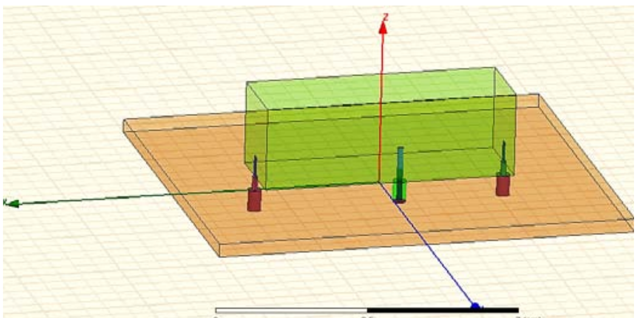
Different excitation techniques have been employed in antenna which helps in making the system to radiate well. Most popular techniques are coaxial probe feed, micro-strip line, aperture coupling and proximity coupling.. Proposed Antenna is excited using coaxial probe fed technique. Coaxial probe feeding is feeding method in which the inner conductor of the coaxial is attached to the radiating element of the antenna while the outer conductor is connected to the ground plane.

III. Antenna Design

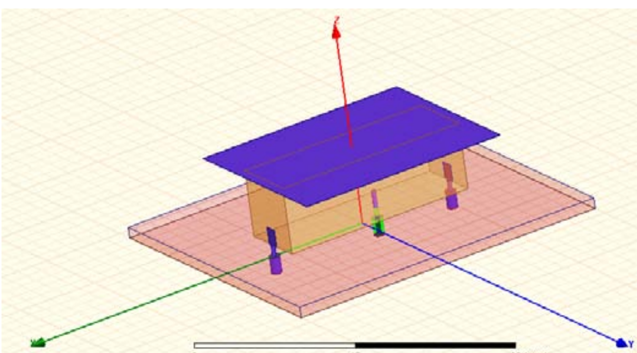
The proposed design uses a substrate of material Rogers RT/Duroid 5880 (tm) having relative permittivity of 2.2 and dimension 10 cm X 9 cm X 0.32 cm. In order to minimize the back-lobe radiation phenomenon, upper surface of antenna has a finite conductivity layer. The rectangular dielectric resonator of relative permittivity 15 is used, having dimension of 5.352 cm X 1.784 cm X 1.784 cm. The co-axial probe feed mechanism is used for the excitation of antenna. Antenna microstrip patch has been calculated by using eqn. 1-5, mentioned in section II. Width of the Patch is 65.84mm and length of the patch is 53.59 mm. Figure 1, shows the modeled 3D view of antenna system.



(a)



(b)



(c)

Figure 1 : 3D view of the modeled antenna (a) RDRA ("Antenna 1") (b) Multi-feed RDRA ("Antenna 2") (c) Patched Multi-feed RDRA ("Antenna 3")

IV. Simulation

Designed antenna is simulated on Ansoft HFSSv13 simulation software. The parametric variation of the project was done by choosing different radiating antenna. Result obtained was studied in detail to know the relation between dielectric and patching. Simulation was performed in three steps.

Firstly, Antenna 1 was designed and analyzed to obtain its characteristics. Figure 2 (a), (b) and (c) present return loss, VSWR and impedance of RDRA. It is found that antenna has resonant frequency of 1.5GHz having return loss of -21.82dB. VSWR of the system is 5dB and impedance is well matched at the resonating frequency. It has only real part, which confirms antenna radiating efficiently at 1.5GHz.

In second simulation process, Antenna 2 has been simulated. Figure 3 (a), (b) and (c), show return loss, VSWR and impedance of multi-feed RDRA (Antenna 2). It is well matched at 3.32GHz and 4.14GHz. Return loss at these frequencies is found to be -17.48dB and -27.86dB respectively. VSWR value decreased to approximate value of 2. Impedance of system has real value at operating frequency of 3.32GHz. Antenna 2 has better characteristics, than that of Antenna 1. Return loss of system has further improved, whereas multi-feed RDRA has multi-frequency of operation, only the fact is that antenna needs impedance matching more in comparison to Antenna 1.

In third simulation process, Antenna 3 has been simulated and results have been shown in figure 4. Figure 4 (a), (b), (c), (d) and (e), presents antenna's return loss, VSWR, Impedance vs. frequency, EH-field in terms of radiation pattern and directivity of the antenna system respectively. Frequency of operation is found to be at 4.14GHz at return loss of -36.32dB. VSWR value is 1.2. Impedance value is lowered than that of Antenna 2 and 1, thus patch has additional advantage over RDRA and multi-feed RDRA. Radiation pattern in terms of field parameters is shown in Figure 4 (d). It shows that H-plane has maximum value in $\theta = 90^0$ while E-plane has the minimum value in this direction and maximum value in $\varphi = 0^0$. Figure 4 (e), shows directivity of the system. It is observed that antenna has directional pattern and concentration of energy in direction of angle 40^0.

Antenna has radiation efficiency of 135%, 101% and 99% respectively. It is found that as antenna is being multi-feed, its frequency range of applicability increases whiles its radiation efficiency decrease but because of advantage, antenna can be multi-feed, through different ports.

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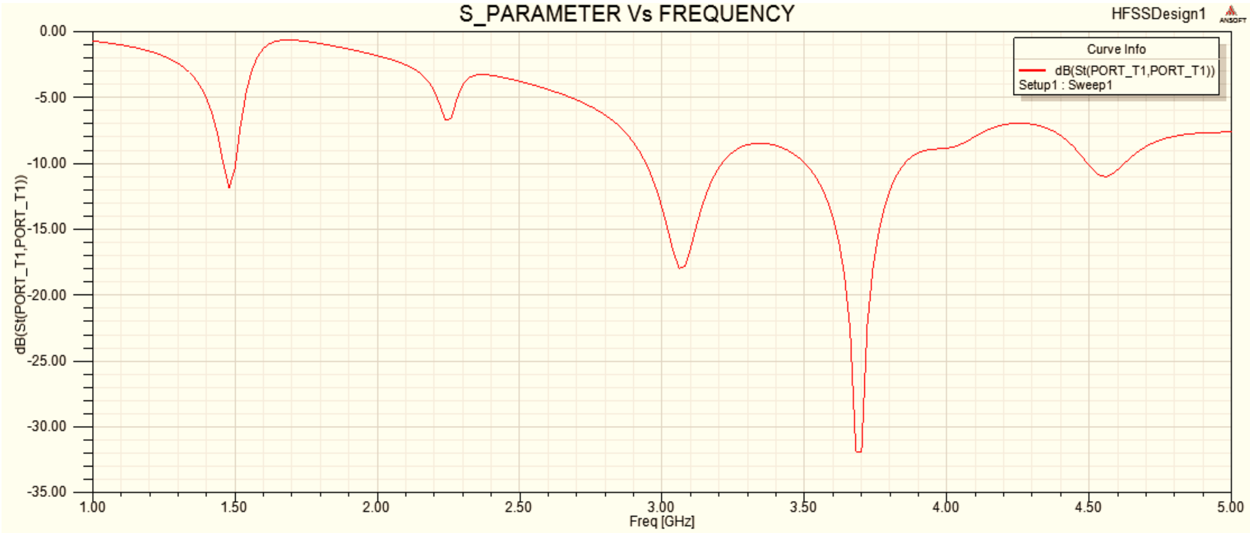

Figure 2 (a) : Return Loss Curve of "Antenna 1"

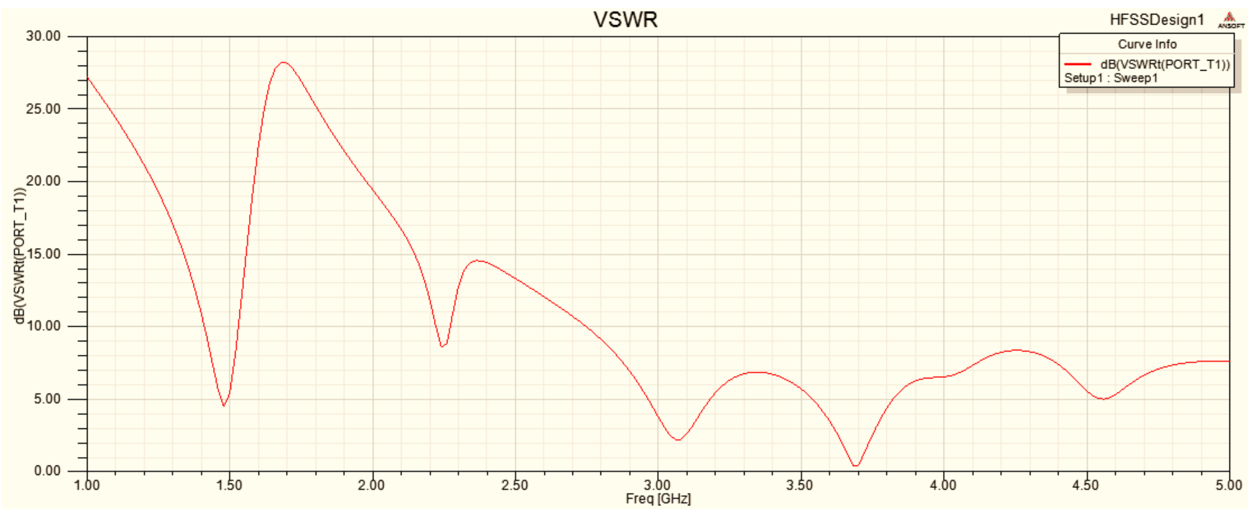

Figure 2 (b) : VSWR vs. Frequency Plot of "Antenna 1"

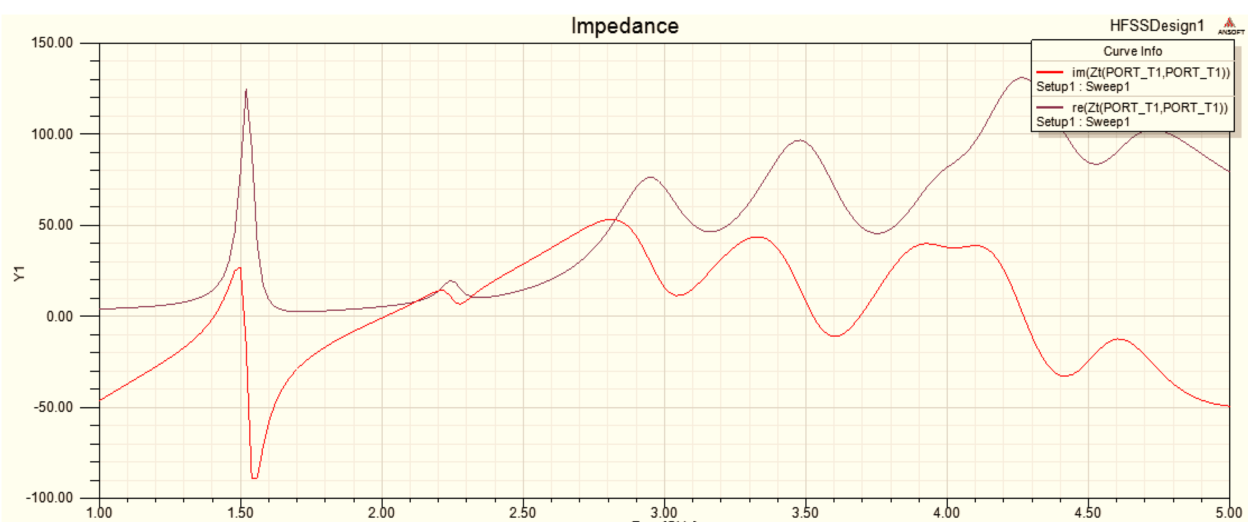

Figure 2 (c) : Impedance vs. Frequency curve of "Antenna 1"

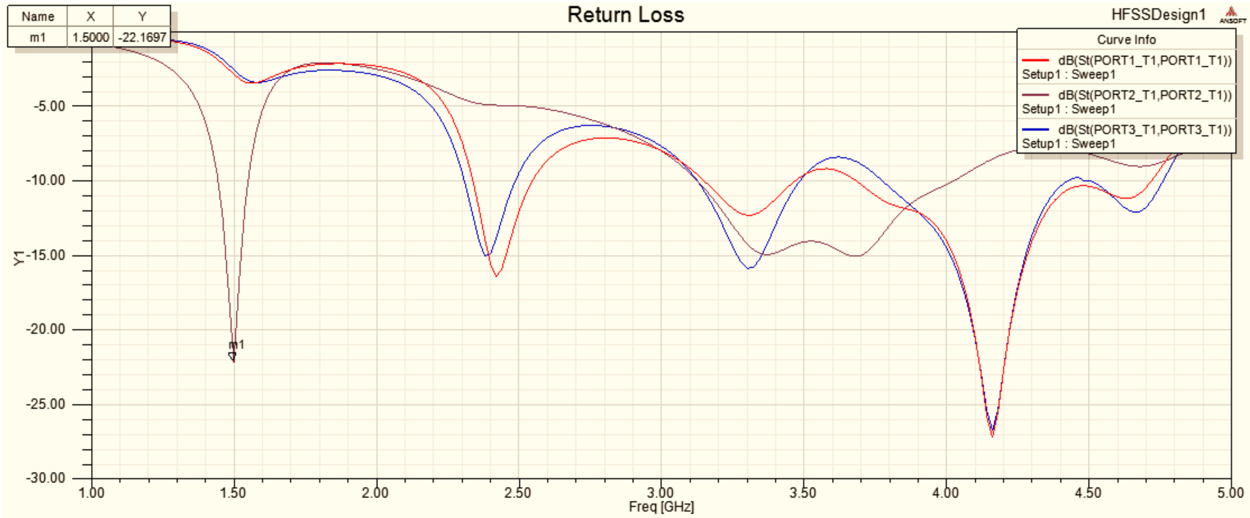

Figure 3 (a) : Return Loss Curve of "Antenna 2"

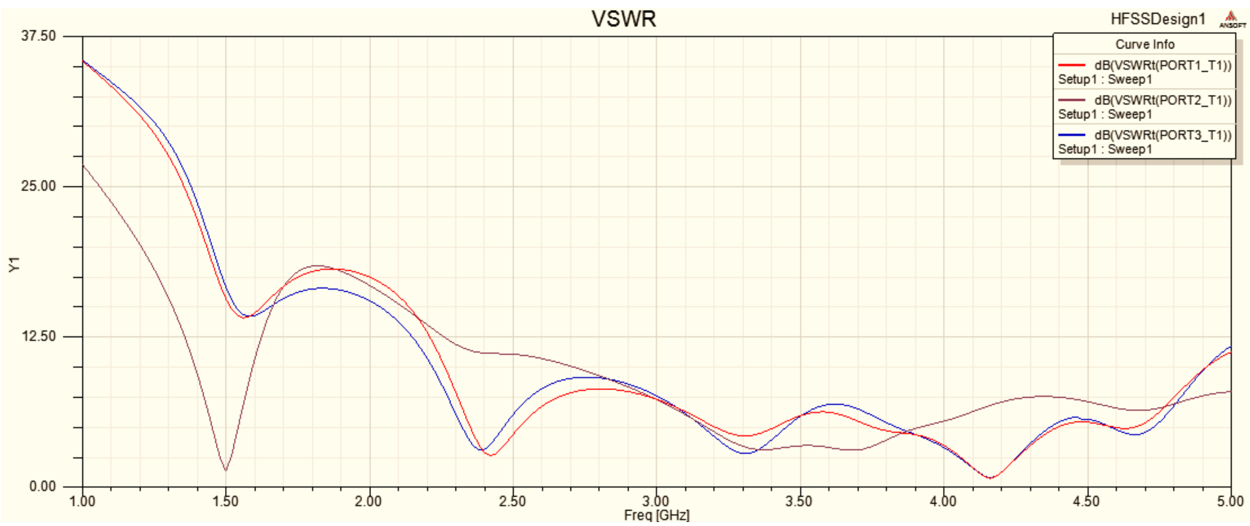

Figure 3 (b) : VSWR vs. Frequency Plot of "Antenna 2"

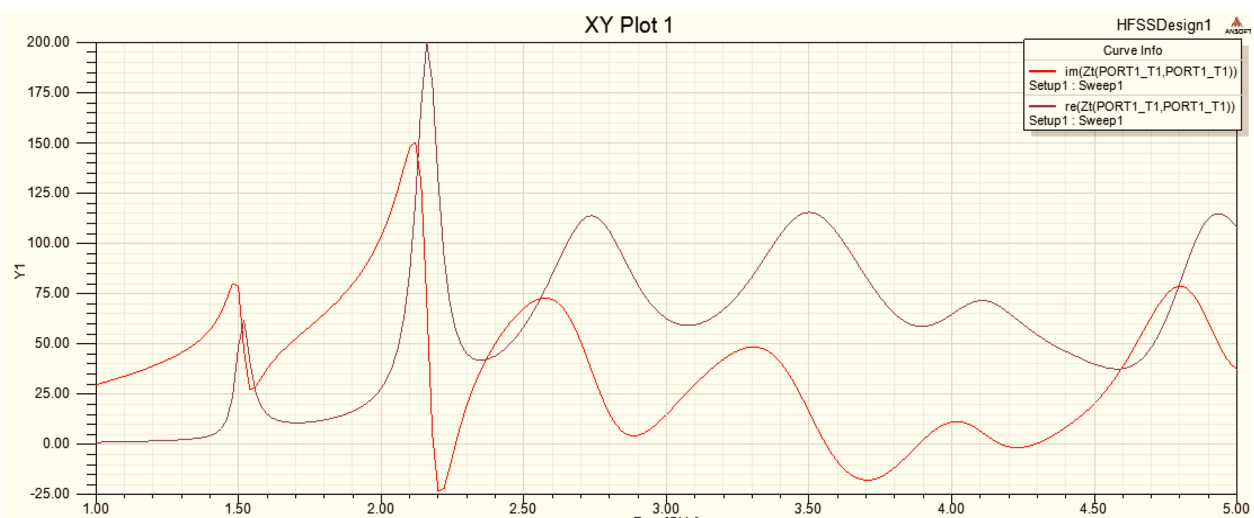

Figure 3 (c) : Impedance vs. Frequency curve of "Antenna 2"

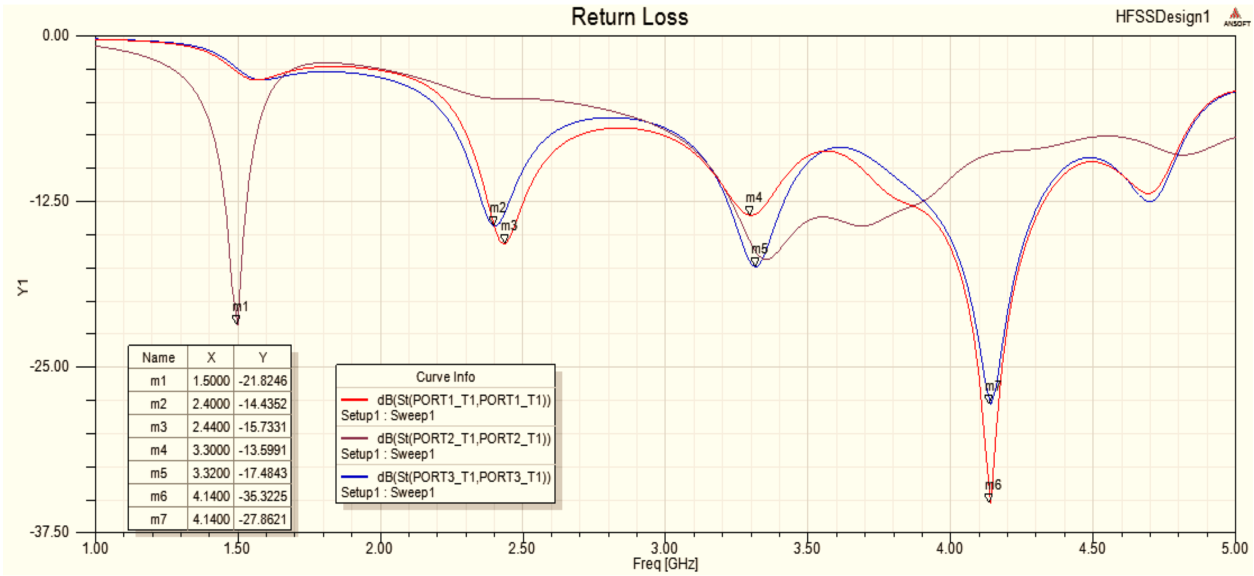

Figure 4 (a) : Return Loss Curve of "Antenna 3"

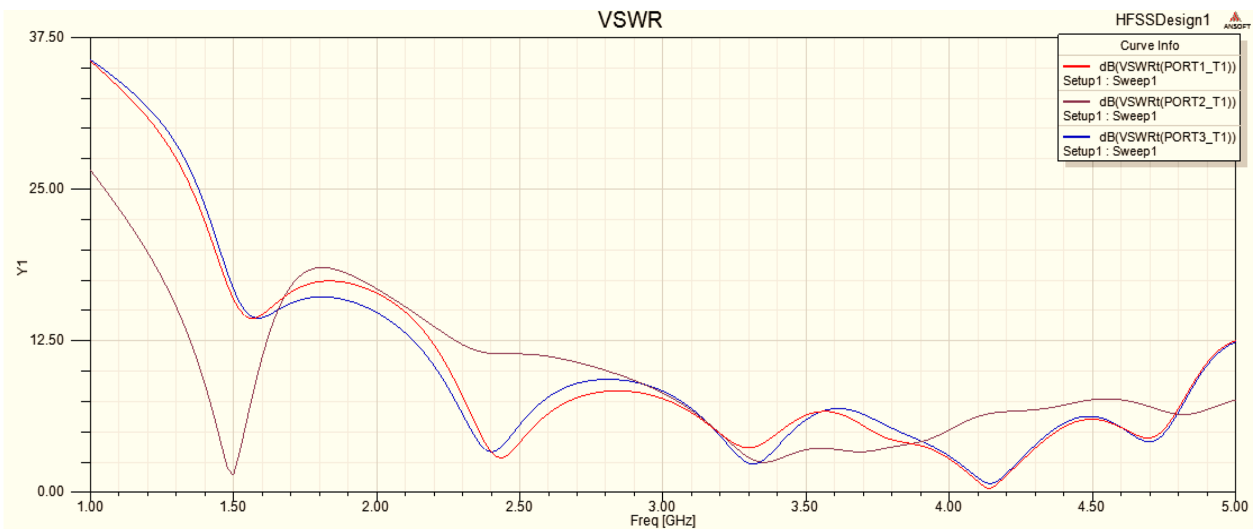

Figure 4 (b) : VSWR vs. Frequency Plot of "Antenna 3"

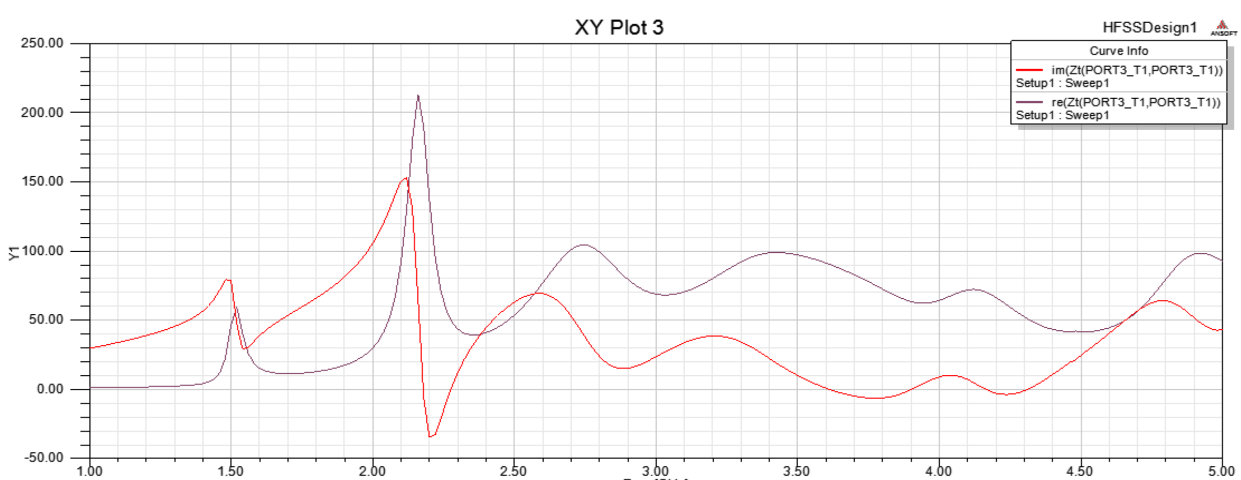

Figure 4 (c) : Impedance vs. Frequency curve of "Antenna 3"

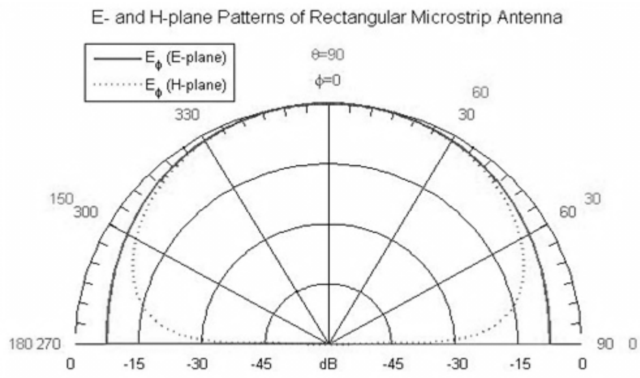

Figure 4 (d) : EH-field of "Antenna 3" in terms of Radiation Pattern

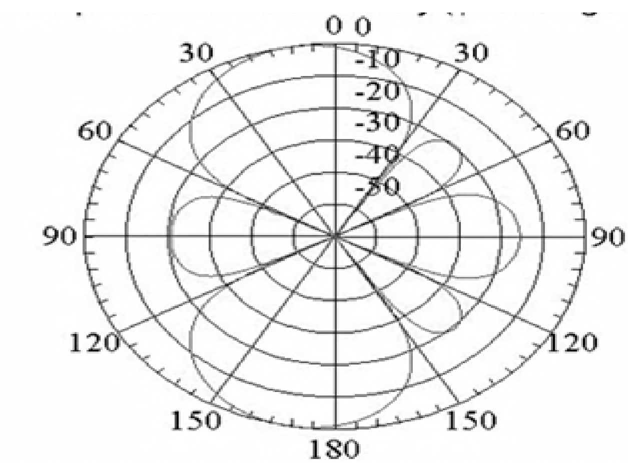

Figure 4 (d) : Directivity of "Antenna 3" in terms of Radiation Pattern

V. Green Technology

This radiating system satisfies growing demand of technology in a green way. Following are the points which support the statement:

1. Antenna serves the purpose of three different antennas, which are operating at three different frequencies 1.5 GHz, 3.32 GHz and 4.14GHz. Therefore, implementation of the antenna can be done for three different antennas, and power requirement will be less for excitation of single antenna than a group of antenna.
2. Radiation efficiency of antenna is more than 99%, if excited from any of the excitation port.
3. Antenna, acts and directed more efficiently at an angle 40^0, i.e., directivity of antenna is maintained at this angle. Further, single processing can be applied to the output of antenna at the transmitter end, which can make this antenna acts "*Smartly*".

VI. Conclusion

Antenna has been successfully designed and experimentally verified. Its multi frequency operability has been most advantageous property within most commonly used frequency range, 1.5GHz, 3.32GHz and 4.14GHz and having return loss in optimum value. Antenna is also suitable candidate for Green Technology and has been supported with positive points. Its operating frequency has been verified for GSM and wireless communication system applications. Also, the VSWR value is restricted to 1.2 and directional directivity pattern has been obtained. Further, it requires a impedance matching circuits, which must be incorporated to increase the energy radiation effectively.

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An Adder with Novel PMOS and NMOS for Ultra Low Power Applications in Deep Submicron Technology

By Ch. Ashok Babu, J.V.R. Ravindra & K. Lal Kishore
Amity University, India

Abstract- Power has become a burning issue in modern VLSI design, as the technology advances especially below 45nm technology, Leakage power become more problem apart of the dynamic power. This paper presents a full adder with novel PMOS and NMOS which consume less power compare to conventional full adder and DTMOS full adder, this paper shows different types of adders and their power consumption, area and delay. All the experiments have been carried out using cadence virtuoso design lay out editor which shows power consumption of different types of adders[1-2].

Keywords: average power, leakage power, delay, DTMOS, PDP.

GJRE-F Classification : *FOR Code: 090607*

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An Adder with Novel PMOS and NMOS for Ultra Low Power Applications in Deep Submicron Technology

Ch. Ashok Babu [α], J.V.R. Ravindra [σ] & K. Lal Kishore [ρ]

Abstract- Power has become a burning issue in modern VLSI design, as the technology advances especially below 45nm technology, Leakage power become more problem apart of the dynamic power. This paper presents a full adder with novel PMOS and NMOS which consume less power compare to conventional full adder and DTMOS full adder, this paper shows different types of adders and their power consumption, area and delay. All the experiments have been carried out using cadence virtuoso design lay out editor which shows power consumption of different types of adders[1-2].

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I. Introduction

The adder is one of the most critical components of a central processing unit. The object of the adders not only adding of bits but also involves in address calculation, subtraction, division and multiplication, the adders are critical components to determine the speed, delay and power of the overall system, low power adders are always preferable. Due to the popularity of portable electronic products low power system has attracted more attention in recent years, an system on chip (SOC) design can contain more and more components that lead to a higher power density. This makes power dissipation reach the limits of what packaging, cooling or other infrastructure can support, reducing the power consumption not only can enhance battery life but also can avoid the overheating problem which would increase the difficulty of packaging or cooling. Therefore the consideration of power consumption in complex SOCs has become a big challenge to designers, moreover in modern VLSI designs [3-5].

Lowering power is one of the greatest challenges facing the IC industry Today, temperature profile and battery life requirements for tethered and un tethered systems have made power consumption a primary optimization target for IC industry[2]. IC power consumption consists of three basics components: switching power, short circuit power and leakage power[6-7].

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Dynamic power $P_D = \frac{1}{2} C_L f\ V_{DD}^2$ (1)

Dynamic power is square of supply voltage, therefore by reducing supply voltage we can reduce dynamic power [8].

The leakage power is mainly due to sub threshold current and it may be defined as the drain to source current of the transistor operating in the weak inversion region of MOSFET this subthreshold leakage may be defined as in eq (2) give s a simple method for estimating the leakage current in a single NMOS transistor[9-11].

$$I_s = I_0 \exp\left[\frac{(V_{gs} - v_t)}{\eta V_t}\right]\left[1 - \exp\left(\frac{V_{ds}}{v_t}\right)\right] \quad (2)$$

V_t is the thermal voltage and is given by Q/KT and n is the sub threshold slope coefficient. Generally there are varies leakage reduction techniques based on mode of operation of systems the two operation modes are active mode and stand by mode or idle mode. Most of the leakage power reduction techniques will be based on idle mode [12].

SECTION2: gives an overview of the Novel PMOS and NMOS and their simulation results, SECTION3 presents Novel 3 bit full adder and conventional full adder, SECTION 4 describes experimental results of conventional, Novel full adders and DTMOS full adders, SECTION5gives conclusions.

II. An Over View of Novel PMOS and NMOS

Ultra low power operation plays a major role in designing of CMOS circuits in subthreshold regime, for any digital or analog design the basic components are PMOS and NMOS devices, the power consumption of this basic elements determine the overall power of the system. In this section we provide Novel PMOS and NMOS, simulations have been carried out in cadence design frame work to verify the functionality of the technique, the functionality of the both the PMOS and NMOS is verified at 180nm and 45 nm technology[13].

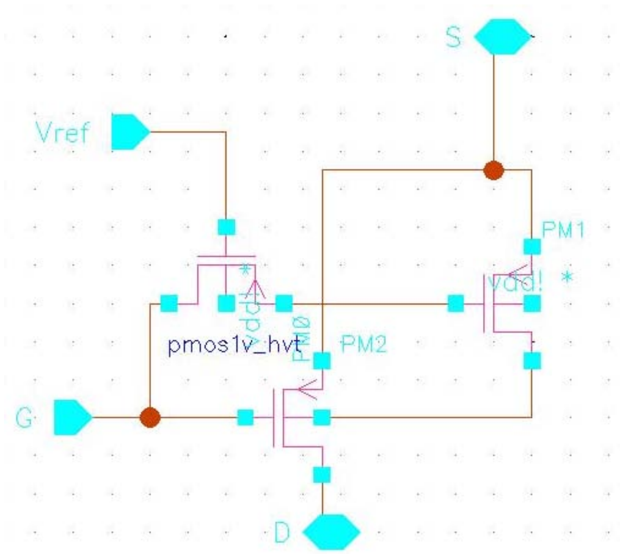

Figure 1 : Novel PMOS

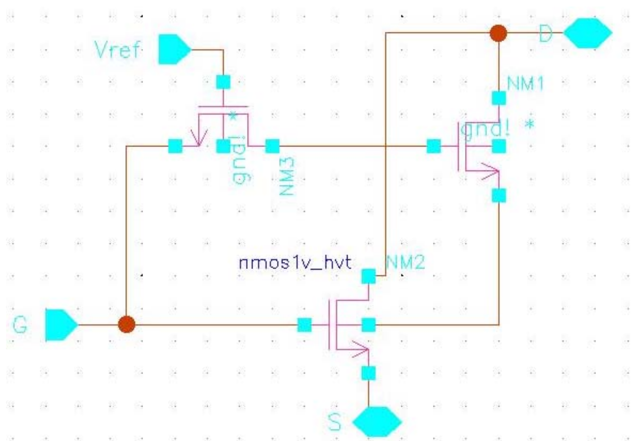

Figure 2 : Novel NMOS

III. A Conventional CMOS Adder

The 28 transistor full adder is the pioneer traditional adder circuit, the schematic of this adder is shown. This adder cell is built using equal number of NFET and PFET transistors, the MOS logic can be realized using equations [1].

Carry: AB+BC+AC (2)

SUM: ABC+(A+B+C)C (3)

The conventional full adder consumes more power compared to Novel full adder, both conventional and Novel full adders are simulated and their average power is calculated [14].

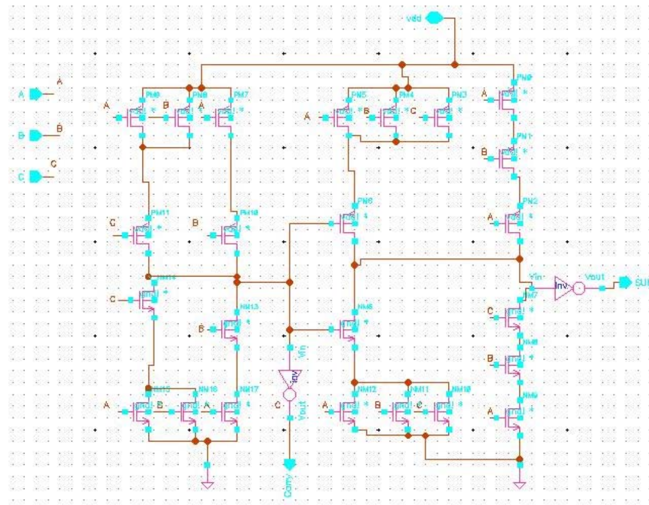

Figure 3 : Conventional full adder

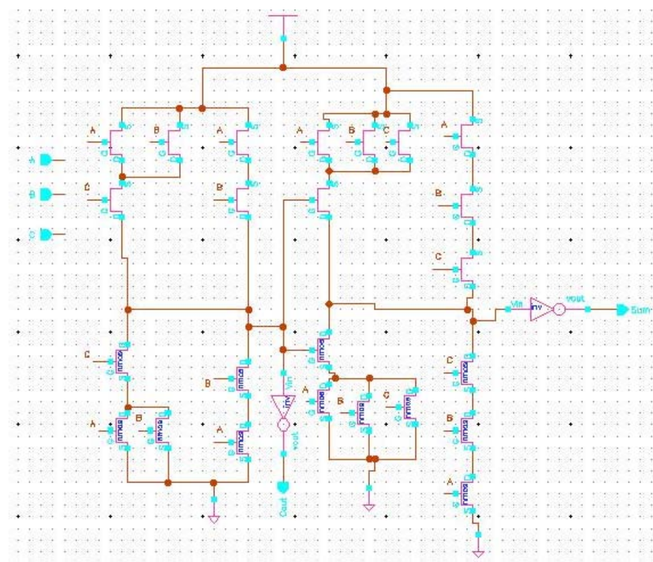

Figure 4 : Full adder with novel PMOS and NMOS

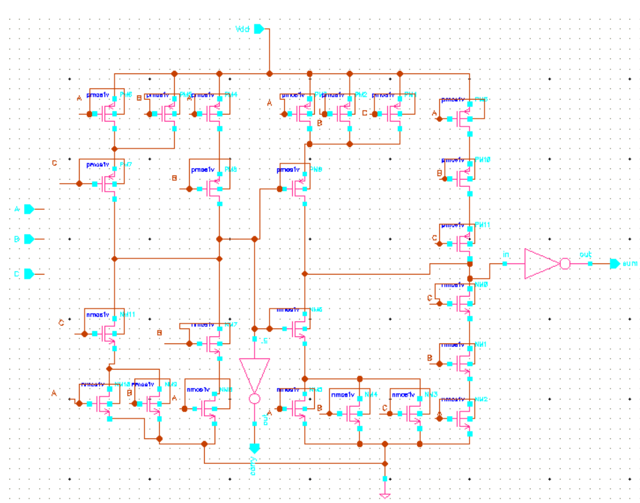

Figure 5 : DTCMOS Full adder

IV. Simulation Results and Analysis

An investigation has been carried out for calculating average power, static power of conventional full adder and the Novel full adder and compared their powers at 45nm technology using virtuoso design environment.

A novel CMOS adder may have an overhead area, but it consumes less power [15].

Table 1 : Power Comparison Table @45nm, Supply Voltage Is 0.6v

Parameter	Full Adder With Novel PMOS & NMOS	Conventional CMOS full adder	DTCMOS full adder
Avg. Power	97.23nw	105.8nw	243nw
Delay	150ps	580ps	291ps
PDP	1.456×10-17	61×10-15	7.07×10-17

Table 2 : Power Delay Comparison Table of Conventional CMOS Full Adder Versus Novel Full Adder at 45nm and Supply Voltage Is 1.1v

Parameter	Full Adder With Novel PMOS & NMOS	Conventional CMOS full adder
Avg. power	0.43μw	1.88μw
Delay	72ps	43ps
PDP	3.152×10^{-17}	8.084×10^{-17}

Table 3 : Power and Delay Comparison of Novel Full Adder and Conventional Full Adder with Supply Voltage of 1.1v @180nm

Parameter	Full Adder With Novel PMOS & NMOS	Conventional CMOS full adder
Avg. power	69.49μw	32.8μw
Delay	217ps	166ps
PDP	15×10^{15}	5.45×10^{15}

Table 4 : Static Power Comparison Table of Novel Full Adder, DTCMOS Full Adder and Conventional Full Adder at 45nm with 0.6v

Parameter	Full Adder With Novel PMOS & NMOS	Conventional CMOS full adder	DTCMOS full adder
Static power when all inputs are at 0.6v	9.159pw	8.688pw	109.4nw
Static power when all inputs are at 0v	14pw	8.756pw	78nw

Table 5 : Static Power Comparison Table of Novel Full Adder and Conventional Full Adder at 45nm With1.1v

Parameter	Full Adder With Novel PMOS & NMOS	Conventional CMOS full adder
Static power when all inputs are at 0.6v	44.6pw	30.97pw
Static power when all inputs are at 0v	52.18pw	28.76pw

Table 6 : Static Power Comparison Table of Novel Full Adder, And Conventional Full Adder At 180nm With1.8v

Parameter	Full Adder With Novel PMOS & NMOS	Conventional CMOS full adder
Static power when all inputs are at 1.8v	30.97pw	69.25pw
Static power when all inputs are at 0v	590pw	97.5pw

V. Conclusions

The performance of many large circuits are strongly dependent on the performance of the full adder circuits that have been used. An attempt has been made to design 84T novel full adder with low power consumption. In this paper we have simulated conventional full adder and Novel full adder and calculated average power. As mentioned earlier as the technology advances apart of dynamic power, there will be a equal part of leakage power, therefore a Novel full adder will suitable for low power design.

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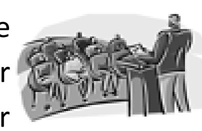

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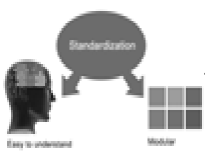

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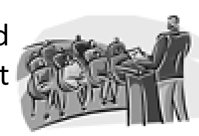

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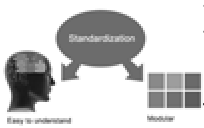

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2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
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- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
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Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
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- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

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- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
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Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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