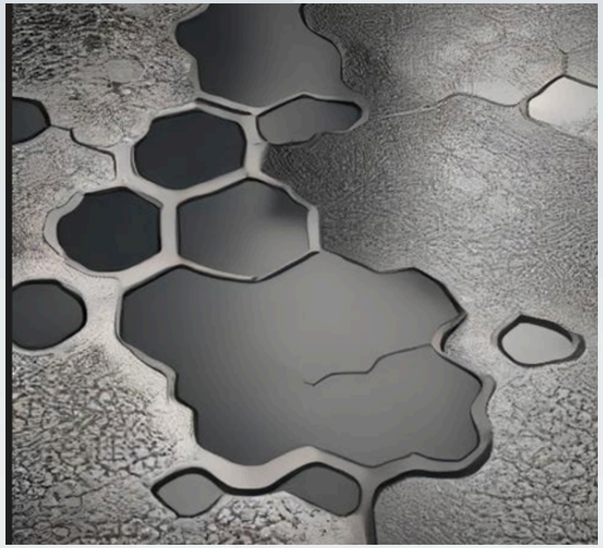
DB NANO

GRAPHENE-BASED ANTI-CORROSION COATINGS

REVOLUTIONIZING CORROSION PREVENTION



PRESENTED BY: DIPAK KR CHANDA

DATE - 25/03/2024

INTRODUCTION TO CORROSION

UNDERSTANDING CORROSION

Definition: Gradual degradation of metals and alloys due to chemical/electrochemical reactions.

Graphene, a highly conductive and flexible material, has been gaining attention for its potential to revolutionize various industries, including corrosion prevention. Here's why graphene offers a promising and environmentally friendly alternative.

Why is corrosion a problem?
Corrosion is a significant issue in various industries, causing damage to infrastructure, equipment, and the environment. Corrosion can lead to:
(a) Economic losses: Corrosion can result in costly repairs, replacements, and downtime,
(b) Environmental hazards: Corrosion can contaminate soil, water, and air, posing health risks to humans and the environment,
(c) Safety risks: Corrosion can lead to structural failures, causing accidents and even fatalities,

HOW DOES GRAPHENE ADDRESS CORROSION?

Graphene's unique properties make it an effective material for corrosion prevention -

- **High electrical conductivity:** Graphene's high conductivity allows it to detect and prevent corrosion by detecting changes in electrical resistance.
- **High mechanical strength:** Graphene's exceptional mechanical properties make it an excellent coating material that can withstand harsh environments and mechanical stress.
- **Chemical resistance:** Graphene is resistant to many chemicals, including acidic and alkaline substances, which are common corrosive agents.

Applications of graphene in corrosion prevention

- **Coatings:** Graphene-based coatings can be applied to metal surfaces to prevent corrosion. These coatings are flexible, lightweight, and can be easily integrated into existing infrastructure.
- **Sensors:** Graphene-based sensors can detect early signs of corrosion, enabling predictive maintenance and minimizing downtime.
- **Composites:** Graphene can be used to create composite materials that combine its benefits with those of other materials, such as polymers or metals.
- **Protective barriers:** Graphene-based barriers can be used to isolate corrosive substances from contacting underlying materials.

ENVIRONMENTAL BENEFITS OF USING GRAPHENE COATING TO PREVENT CORROSION

- **Reduced waste:** Graphene-based solutions can help extend the lifespan of infrastructure and equipment, reducing the need for frequent replacements and waste generation.
- **Low toxicity:** Graphene is biocompatible and non-toxic, making it a safer alternative to traditional corrosion prevention methods.
- **Energy efficiency:** Graphene-based solutions can reduce energy consumption by minimizing the need for frequent repairs and replacements.

Graphene's unique properties make it an attractive solution for corrosion prevention, offering environmental benefits such as reduced waste, low toxicity, and energy efficiency. While there are challenges to overcome, ongoing research and development are pushing the boundaries of what's possible with graphene-based solutions.

CHALLENGES AND FUTURE DIRECTIONS

Graphene, a promising solution for corrosion prevention, there are still challenges to overcome:

- **Scalability:** Large-scale production of high-quality graphene is necessary for widespread adoption.
- **Cost-effectiveness:** The cost of graphene production must be reduced to make it competitive with traditional methods.
- **Integration:** Effective integration of graphene into existing infrastructure and manufacturing processes is crucial.

Importance of Surface Treatment of Milled Steel (MS) with Graphene

Surface treatment of mild steel (MS) with graphene has gained significant attention in recent years due to its potential to enhance the mechanical, thermal, and tribological properties of MS. Graphene, a 2D material composed of carbon atoms arranged in a hexagonal lattice, has been found to have excellent mechanical, thermal, and electrical properties, making it an ideal material for surface modification. Here are some of the importance of surface treatment of MS with graphene:

ADVANTAGES OF GRAPHENE

- **Improved corrosion resistance:** Graphene coating on MS surface can prevent corrosion by reducing the exposure of the metal to corrosive agents, thereby increasing the lifespan of the material.
- **Enhanced mechanical properties:** Graphene can enhance the mechanical properties of MS, such as strength, stiffness, and toughness, by increasing the surface roughness and adhesion between the graphene layer and the metal substrate.
- **Reduced wear and friction:** The addition of graphene on the MS surface can reduce wear and friction between contacting surfaces, leading to increased durability and reduced maintenance costs.
- **Thermal conductivity improvement:** Graphene has high thermal conductivity, which can be utilized to improve the thermal conductivity of MS, making it suitable for high-temperature applications.
- **Environmental protection:** The use of graphene-coated MS surfaces can reduce the environmental impact of metal surfaces by minimizing corrosion and wear, which can lead to increased waste generation.
- **Versatility:** Graphene-coated MS surfaces can be used in various industries, including aerospace, automotive, biomedical, energy storage, and construction.

LIMITATIONS OF CONVENTIONAL COATING TECHNOLOGIES TO PREVENT CORROSION OF MS

Conventional coating technologies (Rust-proofing with oil or grease, Paints and varnishes, Electroplating, Powder coating) have limitations when it comes to preventing corrosion of Mild Steel (MS) -

- **Adhesion:** Conventional coatings may not adhere properly to the metal surface, leading to peeling, flaking, or delamination.
- **Porosity:** Coatings can be porous, allowing moisture and corrosive substances to penetrate and reach the metal surface.
- **Thermal Expansion:** Different thermal expansion coefficients between the coating and metal can lead to cracking or delamination of the coating.
- **Mechanical Damage:** Conventional coatings can be damaged by mechanical stress, scratches, or impacts, compromising their ability to protect the metal.
- **Chemical Resistance**: Some coatings may not be resistant to certain chemicals or substances that can compromise their protective properties.
- **Environmental Factors**: Exposure to UV light, saltwater, or high temperatures can degrade conventional coatings over time.
- **Cost:** Conventional coatings can be expensive, especially for large or complex surfaces.

DB NANO GRAPHENE

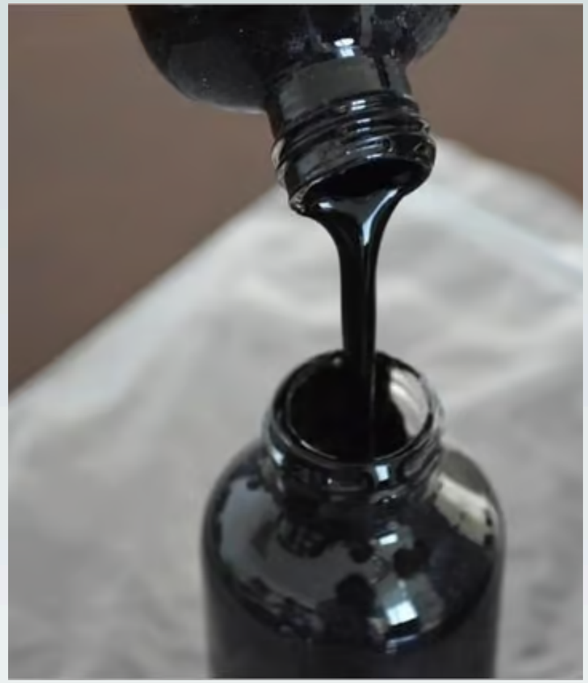
DB Nano is at the forefront of innovation with its pioneering production of green, cost-effective, high-quality graphene. Leveraging advanced technology and sustainable practices, the company transforms graphite into superior graphene, which boasts exceptional electrical, thermal, and mechanical properties. This eco-friendly approach not only reduces environmental impact but also offers significant cost advantages. DB Nano’s commitment to excellence ensures that their graphene meets the highest industry standards, making it an ideal choice for a wide range of applications, from electronics, Rust proof coatings to energy storage. Through continuous research and development, DB Nano leads the charge in the next-generation materials revolution.

DB NANO GRAPHENE

Graphene conductive ink/paste

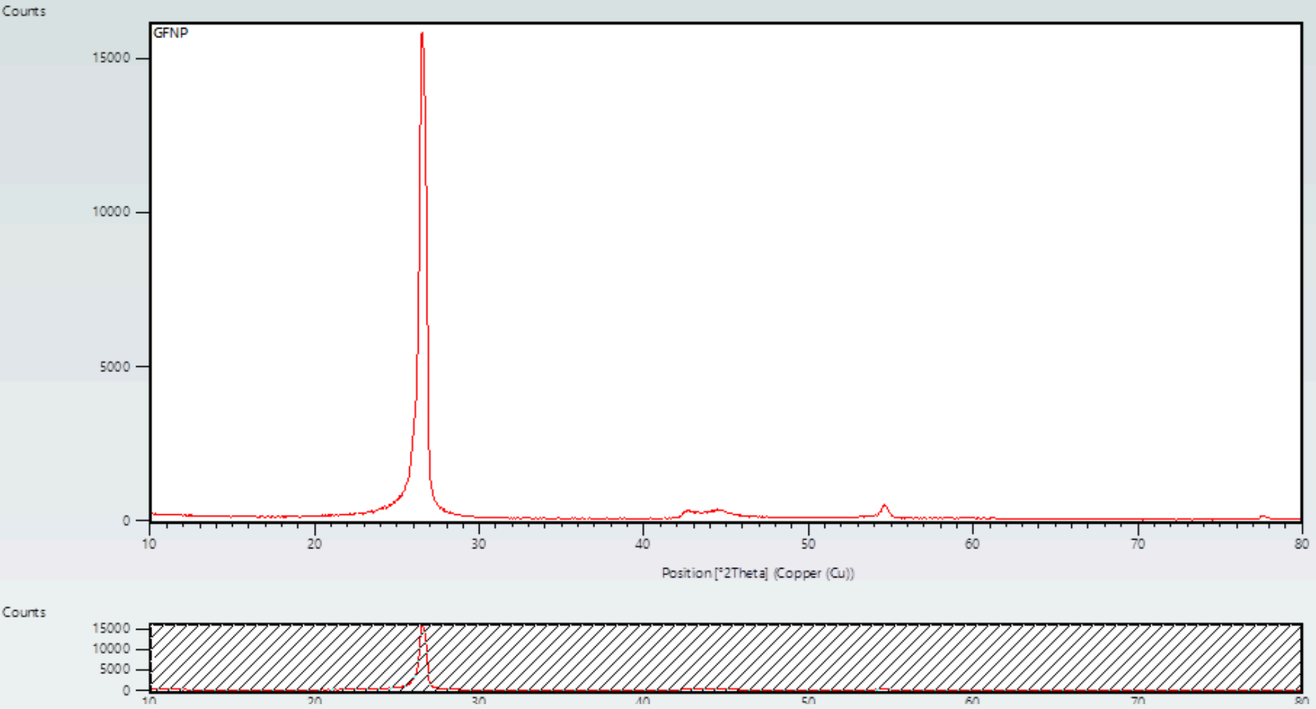
Graphene

% of Carbon : 99%
Powder Density : 0.06-0.09 g/cc
Phase purity : 100% graphitic
No. of layers : 3-8 layers

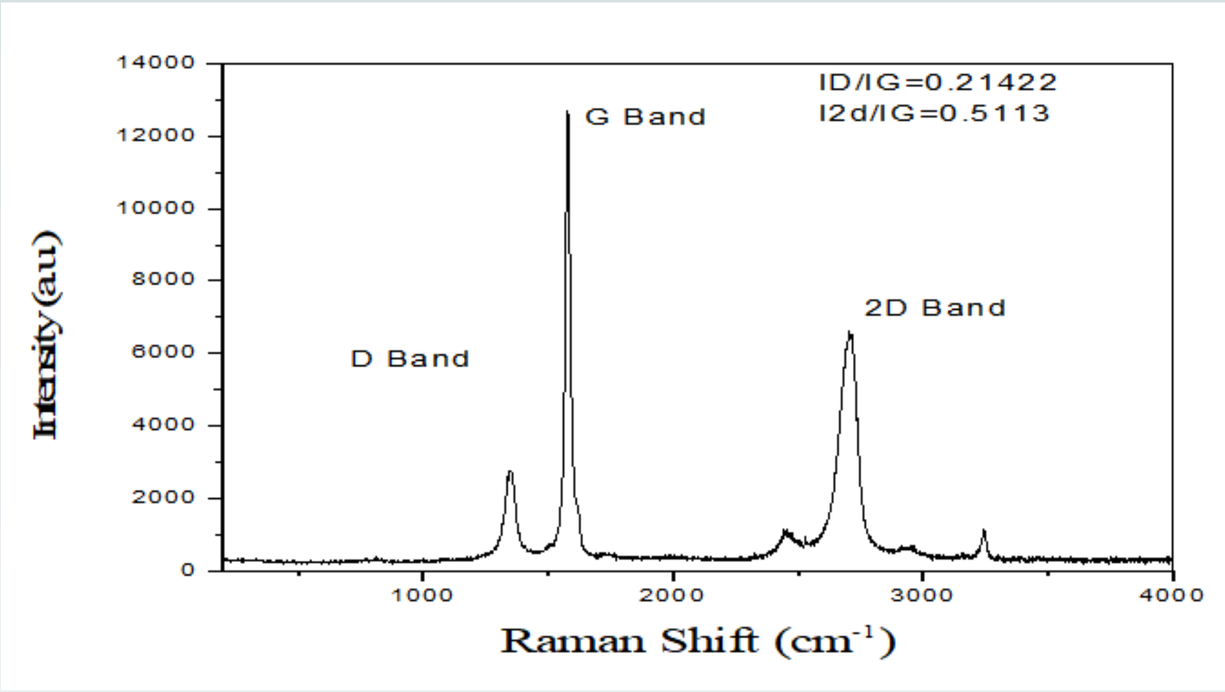


Phenex
Graphene-based anti-corrosion paint

CHARACTERIZATIONS

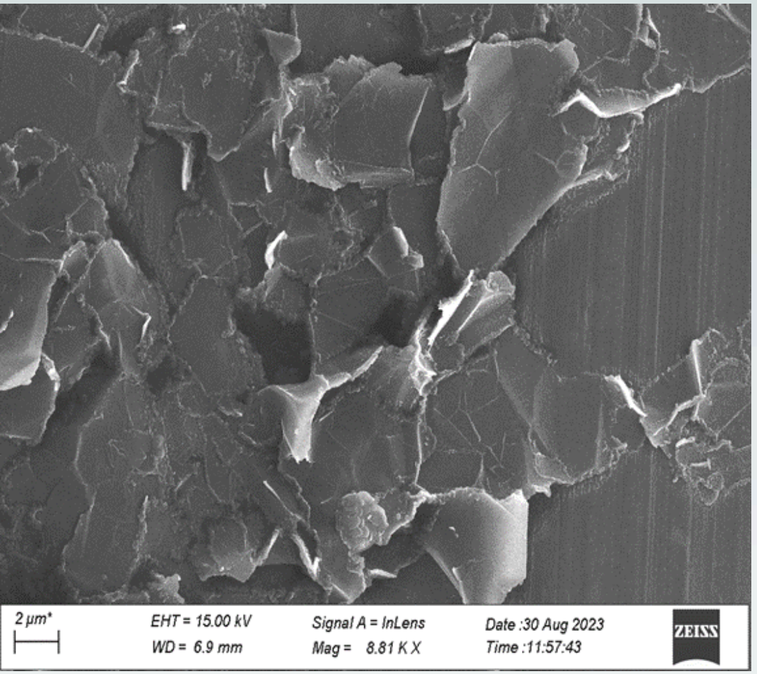


(a) XRD of FR Graphene

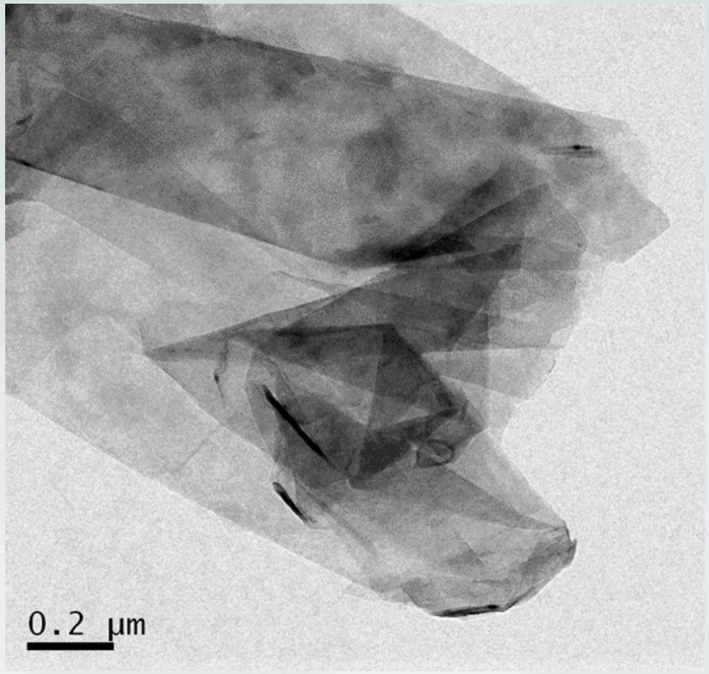


(b) Raman Spectra of FR Graphene

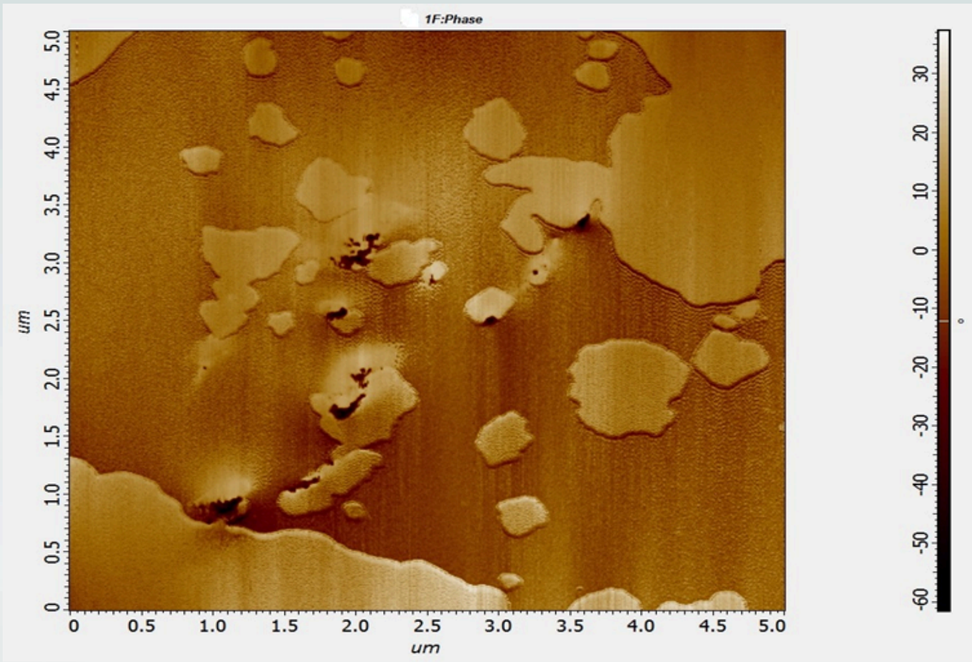
CHARACTERIZATIONS



(a) FESEM of FR Graphene



(b) TEM image of FR Graphene



(c) AFM image of FR Graphene

3 to 8 layers of Graphene is confirmed from above characterizations.

“PHENEX” -
GRAPHENE BASED ANTI RUST COATING ON MILLED STEEL

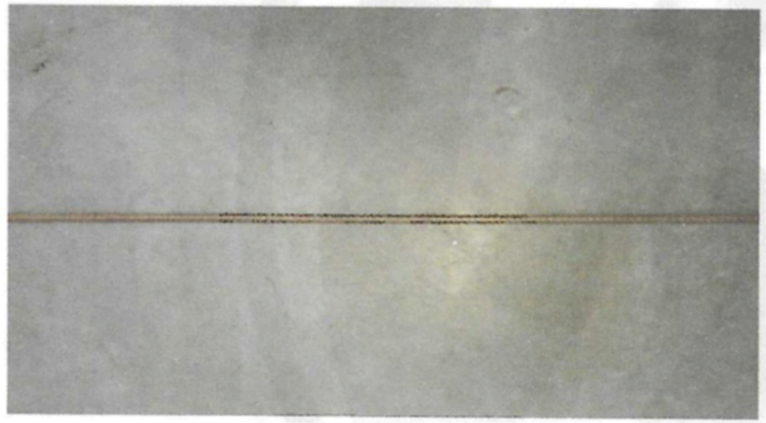
DB Nano has developed a graphene-based anti-rust paint/coating specifically designed for mild steel (MS). This innovative coating leverages the exceptional properties of graphene to provide superior protection against rust and corrosion, enhancing the durability and longevity of MS surfaces in various industrial applications.

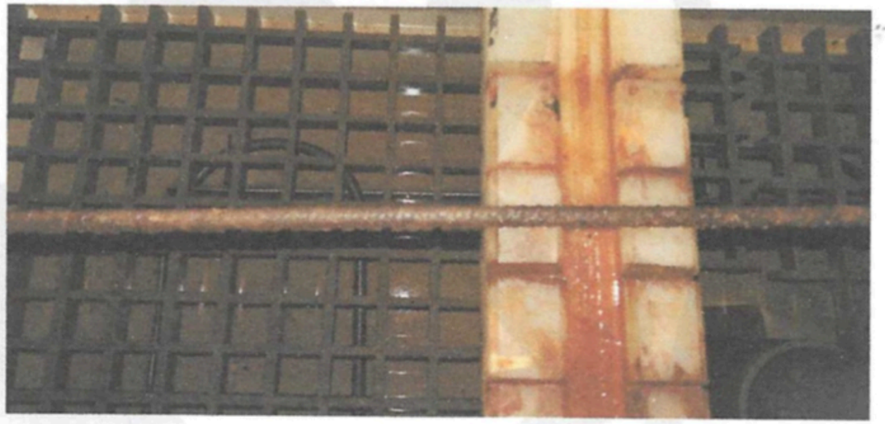
Phenex Coated MS Ribbed Bar

						TC-5243
Sample Description	Without Coated Bar					
Test Method	ASTM B 117 : 2019					
Number of Specimens Tested	01 Nos.					
Exposure in Salt Spray Cabinet (in Hr)	48 Hrs					
Evaluation Requirements	ASTM D 610 - 01					
Equipment Used	Salt Spray Chamber-1					
ENVIROMENTAL CHAMBER CONDITION	**Temperature (In ° C)**	35 ± 2 °C	**pH Value**	**6.5 - 7.2**	**Salt Fog Collection**	1 - 2 ml/hr.

This is to certified that above samples has been tested with the following results:

5 % SALT SPRAY (FOG) CORROSION RESISTANCE TEST REPORT





0 Hr.		After 48 Hrs.			
Sl.No.	**Sample ID**	**Size of blister**	**% of Surface Rusted**	**Reference Standard**	**Observation sample after 48 Hrs.**
1	Without Coated Bar	No Blisters	2.0%	Refer to ASTM D610 - 01	Red Rust Found

********End of Report*********

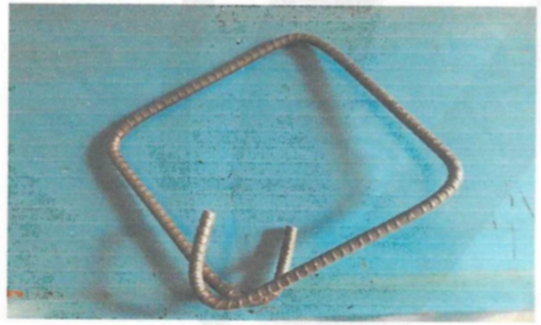
Non Coated MS Ribbed bar after 48 Hrs of salt spray test (2% surface Rusted).

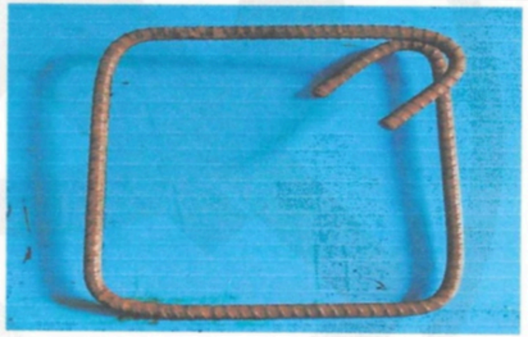
****Report from Adityapur Auto Cluster**

Sample Description (02):	Market available coated Ribbed bar					
Test Method	ASTM B 117 : 2019					
Number of Specimens Tested	01 Nos.					
Exposure in Salt Spray Cabinet (in Hr)	96 Hrs					
Evaluation Requirements	ASTM D 610 - 01					
Equipment Used	Salt Spray Chamber-1					
ENVIROMENTAL CHAMBER CONDITION	**Temperature (In ° C)**	35 ± 2 °C	**pH Value**	6.5 - 7.2	**Salt Fog Collection**	1 - 2 ml/hr.

This is to certified that above samples has been tested with the following results:

5 % SALT SPRAY (FOG) CORROSION RESISTANCE TEST REPORT





0 Hr.		After 96 Hrs.			
Sl.No.	**Sample ID**	**Size of blister**	**% of Surface Rusted**	**Reference Standard**	**Observation sample after 96 Hrs.**
1	Market available coated Ribbed bar	No Blisters	G - 2.0 %	Refer to ASTM D610 - 01	Red rust found

********End of Report*********

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3. This Test result relates only to the samples tested.

Tested By

Harun Rasid

(Technical Manager)

Approved By

B.S Mandal

(Quality Manager)

Note :- Sample not drawn by us, Result relates to sample only.

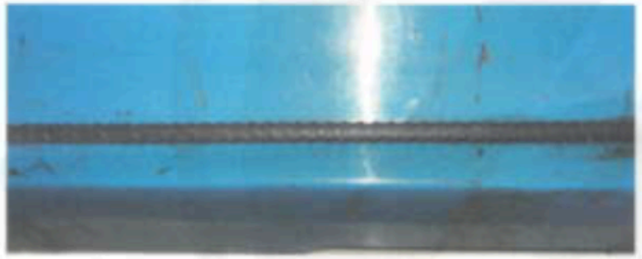
Market available Coated MS Ribbed Bar After 96 Hrs of Salt spray Test (2% surface Rusted).

****Report from Adityapur Auto Cluster**

Sample Description	Painted Twisted M.S Bar					
Test Method	ASTM B 117 : 2019					
Number of Specimens Tested	01 Nos.					
Exposure in Salt Spray Cabinet (in Hr)	216 Hrs					
Evaluation Requirements	ASTM D 610 - 01					
Equipment Used	Salt Spray Chamber-1					
ENVIROMENTAL CHAMBER CONDITION	**Temperature (In ° C)**	35 ± 2 °C	**pH Value**	6.5 - 7.2	**Salt Fog Collection**	1 - 2 ml/hr.

This is to certified that above samples has been tested with the following results:

5 % SALT SPRAY (FOG) CORROSION RESISTANCE TEST REPORT



0 Hr.		After 216 Hrs.			
Sl.No.	**Sample ID**	**Size of blister**	**% of Surface Rusted**	**Reference Standard**	**Observation sample after 216 Hrs.**
1	Painted Twisted M.S Bar	No Blisters	2.5%	Refer to ASTM D610 - 01	Red Rust Found

*********End of Report*********

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ADITYAPUR AUTO CLUSTER

Tested & Approved By

Harun Rasid

Harun Rasid

(Technical Manager)

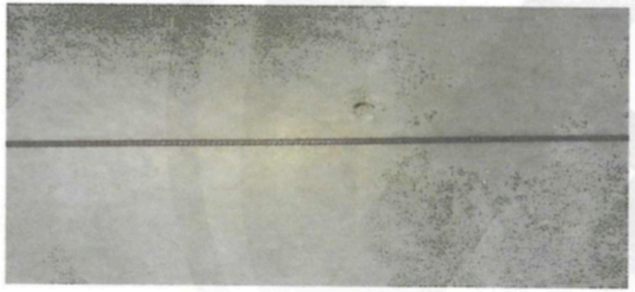
Market available paint (BJ) coated MS Ribbed Bar after 216 Hrs of salt spray test (2.5% surface Rusted).

****Report from Adityapur Auto Cluster**

Sample Description	Graphene Coated Bar					
Test Method	ASTM B 117 : 2019					
Number of Specimens Tested	01 Nos.					
Exposure in Salt Spray Cabinet (in Hr)	600 Hrs					
Evaluation Requirements	ASTM D 610 - 01					
Equipment Used	Salt Spray Chamber-1					
ENVIROMENTAL CHAMBER CONDITION	**Temperature (In ° C)**	35 ± 2 °C	**pH Value**	6.5 - 7.2	**Salt Fog Collection**	1 - 2 ml/hr.

This is to certified that above samples has been tested with the following results:

5 % SALT SPRAY (FOG) CORROSION RESISTANCE TEST REPORT



0 Hr.		After 600 Hrs.			
Sl.No.	**Sample ID**	**Size of blister**	**% of Surface Rusted**	**Reference Standard**	**Observation sample after 600 Hrs.**
1	Graphene Coated Bar	No Blisters	No Rusted	Refer to ASTM D610 - 01	No, any type of rust found.

********End of Report*********

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ADITYAPUR AUTO CLUSTER

Tested & Approved By

Harun Rasid

(Technical Manager)

Note :- Sample not drawn by us. Result relates to sample only.

DB Nano Phenex Graphene Coated MS Ribbed bar after 600 Hrs of salt spray test (no rust found).

****Report from Adityapur Auto Cluster**

CONCLUSION

DB Nano has developed a graphene-based anti-rust paint/coating material for mild steel (MS), called “Phenex”, that outperforms other available coating materials in the market. This innovative solution leverages the exceptional properties of graphene, including its superior strength, high conductivity, and excellent barrier properties, to provide enhanced protection against rust and corrosion. As a result, it offers longer-lasting durability and improved performance, setting a new standard in protective coatings for MS applications.

THANK YOU