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Kerone Research & Development Centre (KRDC),
B/47, Addl. MIDC. Anand Nagar, Ambernath (East), Thane- 421 506, India
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Batch Microwave Heat Treatment for Exfoliation of Graphene slurry

ISO 9001-2008 | ISO 9001-2015 | EMS 14001 | OHSAS 18001
In Association with SVCH-Technologii, Moscow (Russia)

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Customer :	**M/s. Log9, Bangalore**
Process :	**Batch Microwave Heat Treatment for Exfoliation of Graphene slurry**

TEST REPORT No: 47/KRDC/LAB/17 Mum 17/09/2019

Date Sample reception : 17/09/2019
ID : 47/LAB/126

SAMPLE DESCRIPTION:

Sampling : As Requested
Sample Condition : Acceptable
Quantity : 500 grams
Sampling date : 18/09/2019
Product : Graphene slurry
Requirement : Complete and uniform Exfoliation
Start Date test : 18/09/2019
End Date test : 19/09/2019

LABORATORY EXPERIMENTAL SET UP:

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LAB BATCH MICROWAVE+CONVECTION HEATING SYSTEM SPECIFICATIONS:

Microwave Power	2 kW(CW)
Frequency	2450 MHz ± 50
Convective Power	3.5 kW (air flow 350 l/min at 20°C)
Microwave Exposure Zone (cavity)	1 cubic meter
Mode Stirrer	One
Thermal Monitoring System	Single Channel Fiber Optic: Range -40 to 250°C
Exhaust Power	1HP
Tray Size	450x950x50 mm

ENVIRONMENT-LABORATORY AMBIENT CONDITIONS:

Temperature (degree C)	30°C (±5°C)
Humidity (%)	≤87% RH
Pressure (kN/m2 or kPa)	Not recorded

Note for recommendation: Environmental conditions have a direct impact on test results. Accuracy and consistency of test data are affected by the laboratory conditions

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EQUIPMENTS USED:

Name of Equipment	Picture of Equipment	Specifications
Compact Thermal Imaging Camera		Model: FLIR E-30 Resolution: 160x 120 IR Thermal sensitivity of 0.10°C
Thermo Hygrometer		Model No: HTC-2 Temperature accuracy: ±°C (1.8°F) Temperature resolution: 0.1°C (0.2°F) Humidity range: 10%~99% RH Humidity accuracy: ±5% RH Humidity resolution: 1% RH

SAMPLE PREPARATION AND METHOD/PROCEDURE:

The experiment has been performed on Graphene slurry without adding any additive to speed up the exfoliation rate. For this experimental run, required quantity of given sample has been taken in different pots having different materials, shape and size. These pots have been placed in microwave heating system one at a time and microwave exposure has been given with full intensity for different time cycle depending on product reaction. Observations made on the basis of reaction of sample with microwaves and cycle time for exfoliation of sample.

ANALYTICAL RESULTS:

Microwave Power used: 2 kW

Sr. No.	Pot Material	Initial Wt of slurry (grams)	Cycle Time (minutes)	Final Wt of 3DG (grams)	Volume of 3DG (ml)	Density of 3DG (gm/ml)	Surface Area (mm^2)	Remarks
1.	Ants Alumina (99.9%)	1	2	0.292	170	0.001717647	4180	Complete exfoliation observed

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2.	Ants Alumina (99.9%)	1	1	NA	NA	NA	4180	Exfoliation not observed
3.	Bhise Alumina (99.9%)	1	2	NA	NA	NA	2826	Exfoliation not observed
4.	Bhise Alumina (99.9%)	1	3	0.305	220	0.001386364	2826	Complete exfoliation observed
5.	Ants Silica SiC composite	1	2	NA	NA	NA	2826	Exfoliation not observed
6.	Ants Silica SiC composite	1	3	0.298	180	0.001655556	2826	Complete exfoliation observed
7.	Log9 bangalore Clay small-185 mm ID	3	1	NA	NA	NA	24040	Exfoliation not observed
8.	Log9 bangalore Clay small-185 mm ID	3	2	NA	NA	NA	24040	Exfoliation not observed
9.	Log9 bangalore Clay small-185 mm ID	3	3	NA	NA	NA	24040	Exfoliation not observed
10.	Log9 bangalore Clay small-185 mm ID	3	5	NA	NA	NA	24040	Partial exfoliation observed
11.	Log9 bangalore Clay small-185 mm ID	3	7	1.039	820	0.001267073	24040	Complete exfoliation observed
12.	Ants Silica (99.9%)	1	3	0.348	150	0.00232	4299	Complete exfoliation observed
13.	Log9 bangalore Clay small-185 mm ID	3	6	NA	NA	NA	24040	Partial exfoliation observed

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14.	Log9 bangalore Clay big-230 mm ID	3	6	NA	NA	NA	39740	Exfoliation not observed
15.	Log9 bangalore Clay small-185 mm ID	3	6	1.072	840	0.00127619	5776	Complete exfoliation observed
16.	Ants Alumina (99.9%)	1	1	NA	NA	NA	2600	Exfoliation not observed
17.	Log9 bangalore Clay big-230 mm ID	3	6	NA	NA	NA	10000	Partial exfoliation observed
18.	Log9 bangalore Clay small-185 mm ID	2	5	0.74	570	0.001298246	5776	Complete exfoliation observed
19.	Log9 bangalore Clay big-230 mm ID	5	5	NA	NA	NA	19600	Partial exfoliation observed

TYPES OF POTS USED:

1. Ants Silica (99.9%)
2. Bhise Alumina (99.9%)
3. Ants Silica Sic Composite
4. Ants Alumina (99.9%)
5. Log9 Bangalore Clay (small &big)

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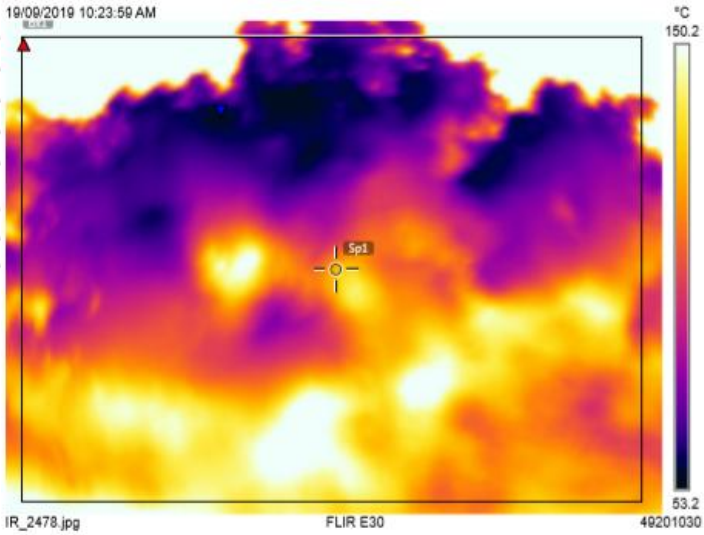
THERMAL IMAGE SHOWING TEMPERATURE PROFILE AFTER TREATMENT:

Measurements		
Bx1	Max	150.2 °C
	Min	55.0 °C
	Average	108.6 °C
Sp1		127.3 °C
Parameters		
Emissivity		0.95
Refl. temp.		20 °C



BEFORE AND AFTER PICTURES OF TREATED SPCIMEN SAMPLE:

BEFORE

AFTER

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OBSRVATIONS:

The reacting behavior of Graphene slurry has been investigated under Batch Microwave Heating System. It has been found that when graphene comes in contact with microwaves it achieves high temperature and after exfoliation very light weight material 3D Graphene is formed. The successful reaction time observed was 2-5 minutes.

Miss. Komal Bhoite
Tested By