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List of Publications

International Journals

1. **Arun Karthick, R**.; Roy, B.; Chattopadhyay, P. A review on the application of chemical surfactant and surfactant foam for remediation of petroleum oil contaminated soil. ***Journal of Environmental Management*** **(Impact factor- 5.647)**. 2019, *243,* 187-205.

2. **Arun Karthick, R**.; Roy, B.; Chattopadhyay, P. Comparison of Zero-Valent Iron and Iron Oxide Nanoparticle Stabilized Alkyl Polyglucoside Phosphate Foams for Remediation of Diesel-Contaminated Soils. ***Journal of Environmental Management*** **(Impact factor- 5.647)**. 2019, *240*, 93-107.

3. **Arun Karthick, R**.; Chauhan, M.; Krzan, M.; Chattopadhyay, P. Potential of Surfactant Foam Stabilized by Ethylene Glycol and Allyl Alcohol for the Remediation of Diesel Contaminated Soil. ***Environmental Technology & Innovation*** **(Impact factor- 3.356)**. 2019, 14, 1-10.

4. **Arun Karthick, R**.; Jangir, K.; Chattopadhyay, P. Foaming and Cleaning Performance Comparison of Liquid Detergent Formulations using Mixtures of Anionic and Nonionic Surfactants. ***Tenside Surfactants Detergents*** **(Impact factor- 0.820).** 2018, 55, 162-168.

5. Chattopadhyay, P.; **Arun Karthick, R**. Characterization and Application of Surfactant Foams Produced from Ethanol-Sodium Lauryl Sulfate-Silica Nanoparticle Mixture for Soil Remediation. ***Macromolecular Symposia***. 2017, 376, 1600182.

6. **Arun Karthick, R**; Chattopadhyay, P. Remediation of Diesel Contaminated Soil by Tween-20 Foam Stabilized by Silica Nanoparticles. ***International Journal of Chemical Engineering and Applications***. 2017, 8, 194-198.

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8. Chattopadhyay, P.; **Arun Karthick, R.** An In-Depth Analysis of Ethanol Based Aqueous

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1. **Arun Karthick, R**; Chattopadhyay, P. Optimization of Parameters Influencing the Nano Zero-Valent Iron Stabilized Surfactant Foam in Remediation of Diesel Contaminated Soils Using Response Surface Methodology (***Environmental Monitoring and Assessment)***

International Conference Proceedings

1. **Arun Karthick. R,** Pradipta Chattopadhyay, "Remediation of Diesel Contaminated Soil by Tween-20 Foam stabilized by Silica Nanoparticles", Proceedings of 4th International Conference on Chemical and Food Engineering (ICCFE 2017), Osaka, Japan, March 28-30, 2017.

2. Pradipta Chattopadhyay, **Arun Karthick. R**, "Characterization and Application of Surfactant Foams Produced from Ethanol-Sodium Lauryl Sulfate-Silica Nanoparticle Mixture for Soil Remediation", Abstract in Proceedings of 2nd International Conference on Soft Materials (ICSM-2016), Jaipur, India, December 12-16, 2016.

3. Pradipta Chattopadhyay, **Arun Karthick. R,** Venkata Vijayan, Soumya Chowdhury, "Optimum Dodecanol-detergent foam performance for formulation of eco-friendly surfactants", Proceedings of World Research Journals Conference (WRC 2015), Dubai, UAE, 7-9th December, 2015.

Book chapter

1. Pradipta Chattopadhyay, **Arun Karthick**, P. Kishore, "Foamability of Foam Generated by Use of Surf Excel and Sodium Lauryl Sulfate", Edited by Dr. Bharat A. Bhanvase, Rajendra P. Ugwekar, Apple Academic Press, ISBN: 9781771883245, 2016

Biographies

Biography of the Candidate

R. Arun Karthick completed B.Tech in Biotechnology from Kalasalingam University, India and M. Tech, in Pharmaceutical Technology from SASTRA University, India. He joined BITS-Pilani, Pilani campus in January, 2015 as a Research Scholar. Currently, he is pursuing Ph.D. in Department of Chemical Engineering, at Birla Institute of Technology and Science (BITS), Pilani campus, Rajasthan, India, under the guidance of BITS Pilani Faculty Pradipta Chattopadhyay. His research interests include surfactants, foams, their characterization and applications in environmental remediation. His current area of research includes experimental studies on characterization of surfactant foams for effective treatment of diesel contaminated soil. He was also involved in the tutorials of courses such as engineering chemistry and process design principles.

Biography of Supervisor

Pradipta Chattopadhyay did B.E. in Chemical Engineering discipline from Jadavpur University, India. He then completed M.S. from Texas A & M University Kingsville, U.S.A. and Ph.D. from University of Tulsa, U.S.A. both in Chemical Engineering. He joined the Department of Chemical Engineering, at Birla Institute of Technology and Science (BITS), Pilani campus, Rajasthan, India, in August, 2009 as Assistant Professor. He has more than ten years work experience as Assistant Professor in Department of Chemical Engineering, at Birla Institute of Technology and science (BITS), Pilani campus, Rajasthan, India. His research interest includes novel surfactant synthesis, aqueous foams, their characterization and applications. He has 13 publications in peer reviewed International Journals, 31 conference proceedings and one book chapter. He is also a member of The Indian Institute of Chemical Engineers, India and Japan Oil Chemists' Society. He is the reviewer of many reputed international journals including Journal of Dispersion Science and Technology. He has guided 5 M.E. dissertation students so far. Currently, Dr. Pradipta Chattopadhyay is guiding 1 PhD student.

Biography of Co-Supervisor

Professor Dr. Banasri Roy is currently associated with Birla Institute of Technology and Science (BITS) Pilani campus, Rajasthan, India, as Associate Professor in Department of Chemical Engineering. She joined as Assistant Professor in Department of Chemical Engineering in BITS Pilani in 2013. She has also been Visiting Assistant Professor in Chemical Engineering in New Mexico Inst. of Tech. Socorro, NM, USA. She holds two post doctorates from New Mexico Inst. of Tech. Socorro, NM, USA, one in Department of Chemical Engineering 2009-2011 and other in Department of Material Engineering 2006-2009. She pursued her doctorate from Colorado School of Mines, Golden, CO, USA in Materials Engineering. She holds two master's degree as well, M.Sc. from New Mexico Inst. of Tech. Socorro, NM, USA 2001 batch and M. Tech. in Materials Engineering, IIT/Kanpur, Kanpur, India 1999 batch. She completed her engineering degree in Chemical Technology from Calcutta University in 1996 and B.Sc.(Hons.) in 1993 from same university.

Till now she has 37 publications in SCI journals, one patent application, around 40 in peer reviewed conferences and she has reviewed approx. 50 articles in refereed journals. Her major publications are:- A review on the application of chemical surfactant and surfactant foam for remediation of petroleum oil contaminated soil, Comparison of zero-valent iron and iron oxide nanoparticle stabilized alkyl polyglucoside phosphate foams for remediation of diesel-contaminated soils, Study of preparation method and oxidization/reduction effect on the performance of nickel-cerium oxide catalyst for aqueous-phase reforming of ethanol, Effect of variable conditions on steam reforming and aqueous phase reforming of n-butanol over Ni/CeO_2 and Ni/Al_2O_3 catalysts, Investigating the Effect of Dopant Type and Concentration on TiO2 Powder Microstructure via Rietveld Analysis, Low temperature solid oxide electrolytes (LT-SOE): A review, Synthesis of Al-doped Nano Ti-O scaffolds using a hydrothermal route on Titanium foil for biomedical applications, Effect of preparation methods on the performance of Ni/Al_2O_3 catalysts for aqueous-phase reforming of ethanol: Part I-Catalytic activity, Aqueous-phase reforming of n-BuOH over Ni/Al_2O_3 and Ni/CeO_2 catalysts. She is currently leading a research project funded by SERB-EMR: Hydrogen Production from Ethanol by Low Temperature Reforming Methods Using Modified $NiSn/Al_2O_3$ and $NiSn/CeO_2$ Catalysts.

Appendix

1. Calculations involved in Fe^0 Synthesis Method

Batch Size - 15 gm

Material	Weight (g)	Solvent
$FeCl_2.4H_2O$	17.8	Ethanol -40 mL
		Water – 10 mL
$NaBH_4$	8.47	Water – 220 mL

Materials required

Sodium borohydride ($NaBH_4$)

$FeCl_2.4H_2O$

Ethanol (99%)

Preparation of essentials

1M Sodium borohydride ($NaBH_4$)

Dissolve 8.47 g $NaBH_4$ in 220 mL of distilled water

2M $FeCl_2.4H_2O$

Dissolve 17.8 g of $FeCl_2.4H_2O$ in 50 mL of absolute ethanol and distilled water solution (4:1v/v).

2. Calculations involved in Fe^0 Synthesis Method

Batch Size - 15 gm

Material	Weight (g)	Solvent
1 M $FeCl_3.6H_2O$	54.1	200 mL - 2M HCl*
2M $FeCl_2.4H_2O$	19.9	50 mL – 2M HCl

* To prepare 2 M HCl Add 21 mL conc HCl to 250 mL water

Materials required

Hydrochloric acid (Concentrated)

$FeCl_{3.}6H_2O$

$FeCl_{2.}4H_2O$

Ammonium hydroxide (Concentrated)

Preparation of essentials:

1M $FeCl_{3.}6H_2O$

Dissolve 54.1 g of $FeCl_{3.}6H_2O$ in 200 mL 2 M HCl

2M $FeCl_{2.}4H_2O$ in 2 M HCl

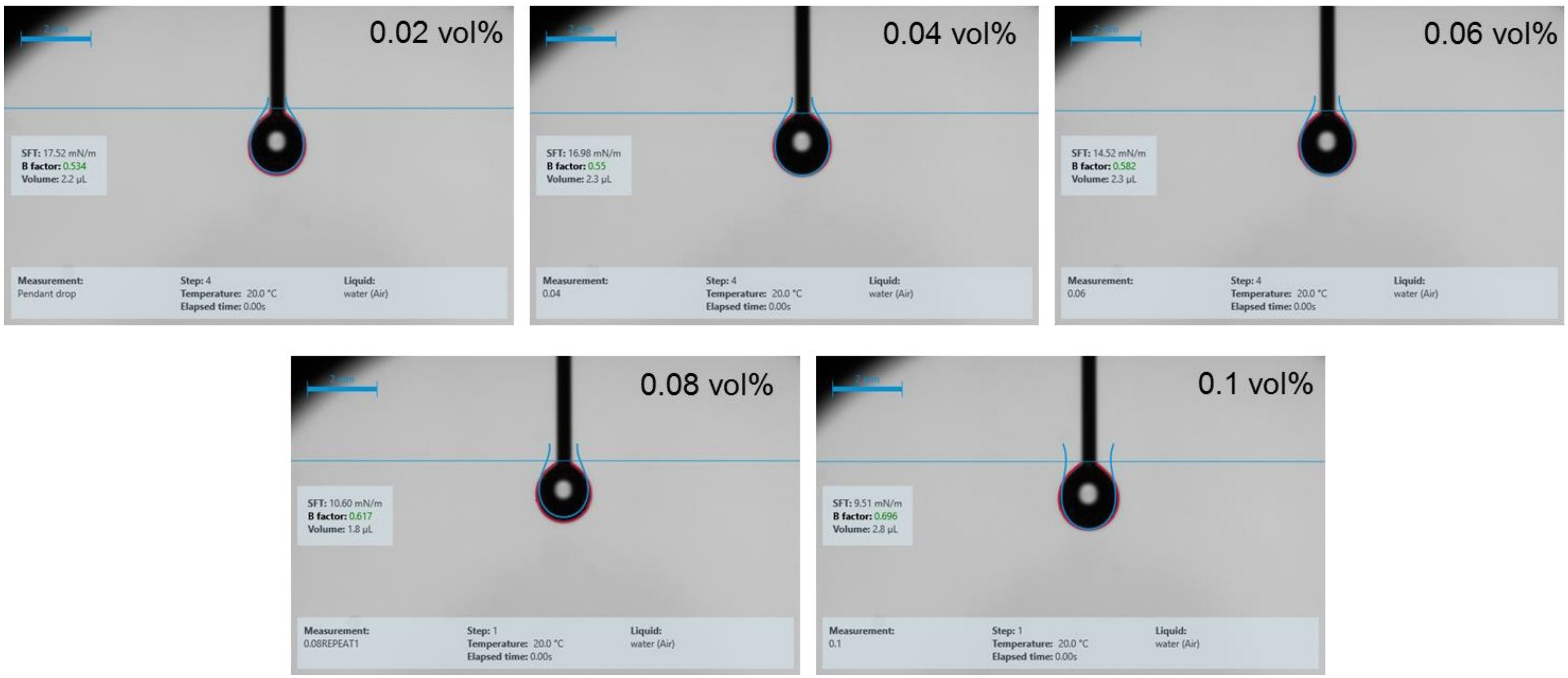
Dissolve 19.9 g of $FeCl_{2.}4H_2O$ in 50 mL 2 M HCl

1M aqueous NH_3 solution

Dilute at least 67 mL of concentrated ammonium hydroxide with water to 1 L

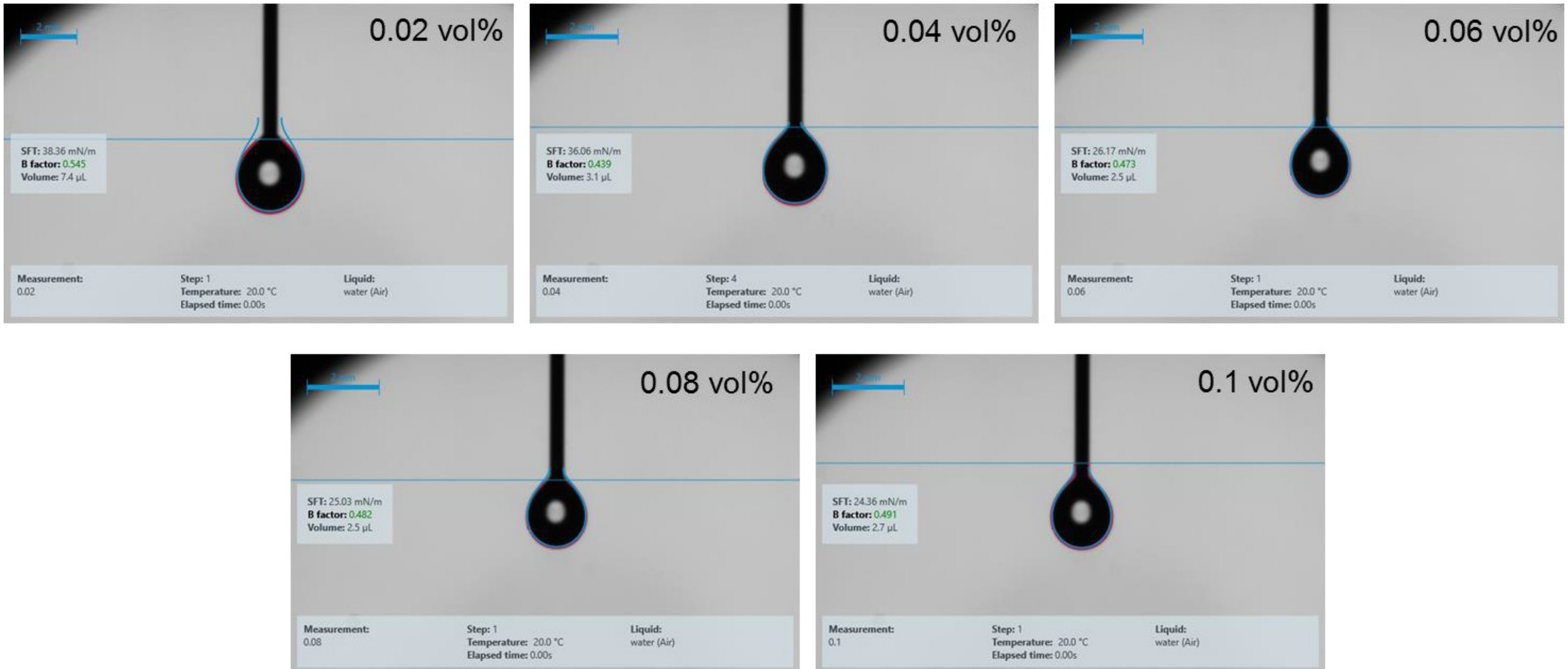
3. Estimation of the surface tension - Axisymmetric image of the pendant drops

3.1 Pure APG-Ph solution



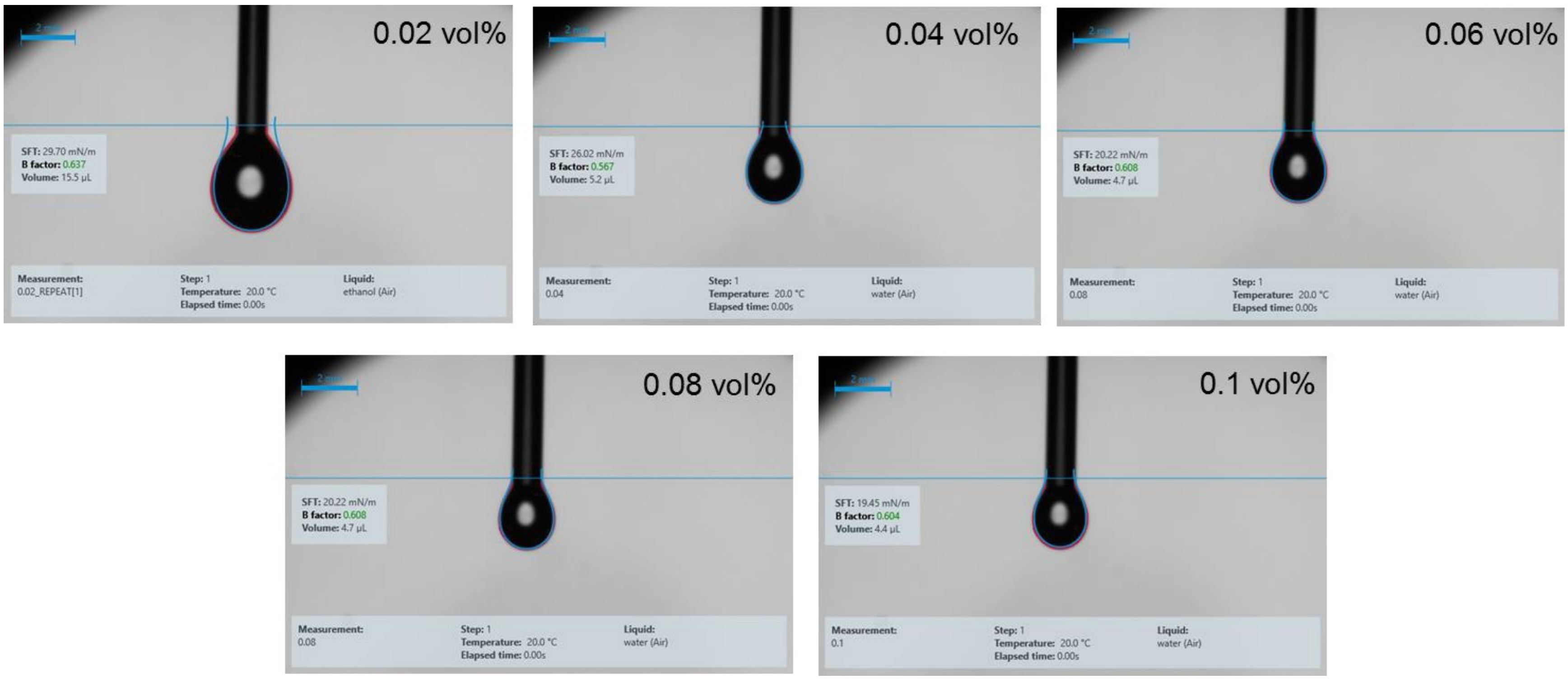
Appendix Fig. 1. Axisymmetric image of the pendant drop used to estimate the surface tension of various concentrations of pure APG-Ph solution.

3.2 Fe^0 (3.5 mg/l) and different concentrations APG-Ph solution



Appendix Fig.2. Axisymmetric image of the pendant drop used to estimate the surface tension of Fe^0 (3.5 mg/l) and various concentrations of dispersion APG-Ph solution.

3.3 Fe_3O_4 (3.5 mg/l) and different concentrations APG-Ph solution



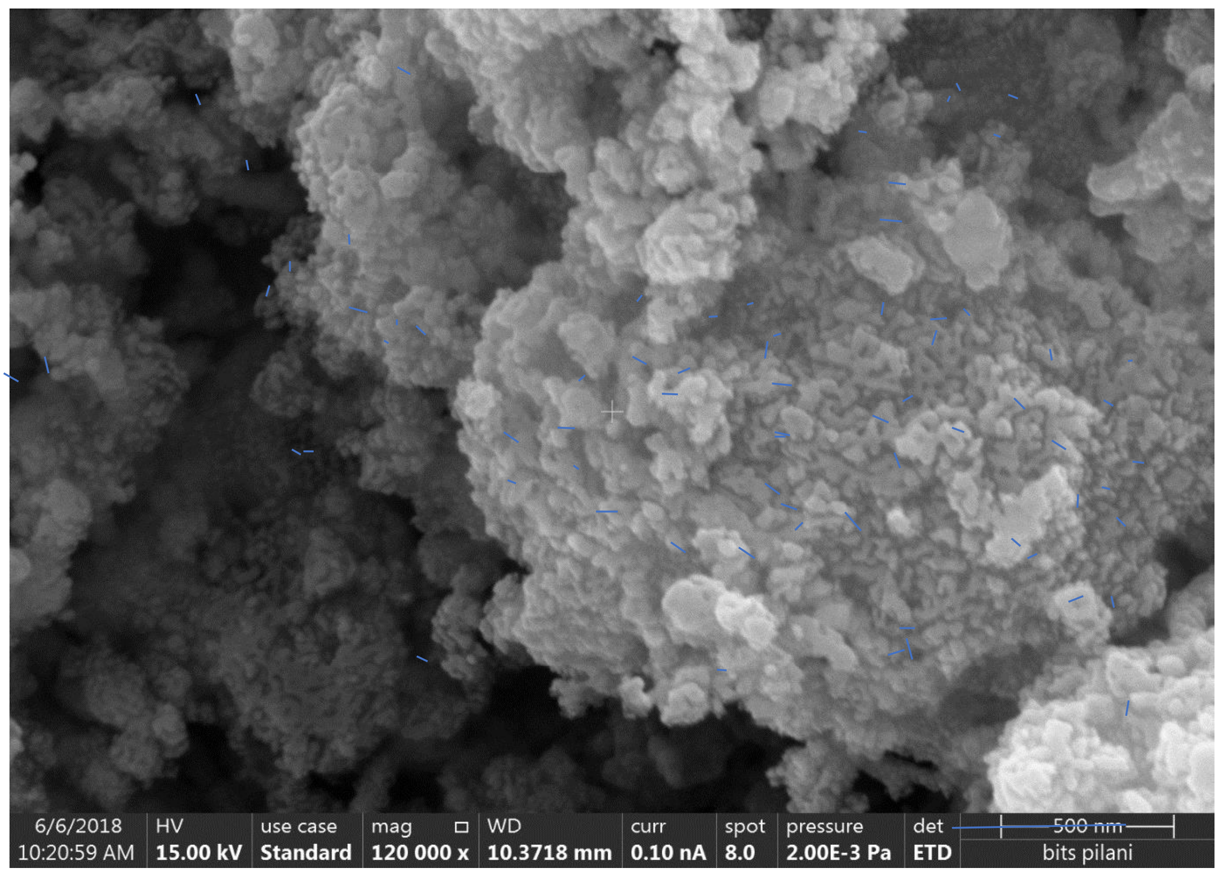
Appendix Fig.3. Axisymmetric image of the pendant drop used to estimate the surface tension of Fe_3O_4 (3.5 mg/l) and various concentrations of dispersion APG-Ph solution.

4. Calculation of particle size from SEM micrographs

Image-j method

- Open the SEM image in ImageJ software
- Calibrate and remove the scale of the selected image
  - Note the dimension of image in pixels
  - Measure the scale of the image in ImageJ software
  - Now set the scale of ImageJ using the scale measured above
  - This now changes the scale to actual image size (pixels)
- Now select the portion of the image where size has to be calculated
- Adjust the threshold of the image to get original size of the nanoparticles
- Make the background dark and analyses the particles to get exact size of particles.

4.1 Fe^0



Appendix Fig.4. Manual calculation of particle size of Fe^0 using the scale obtained from SEM image.

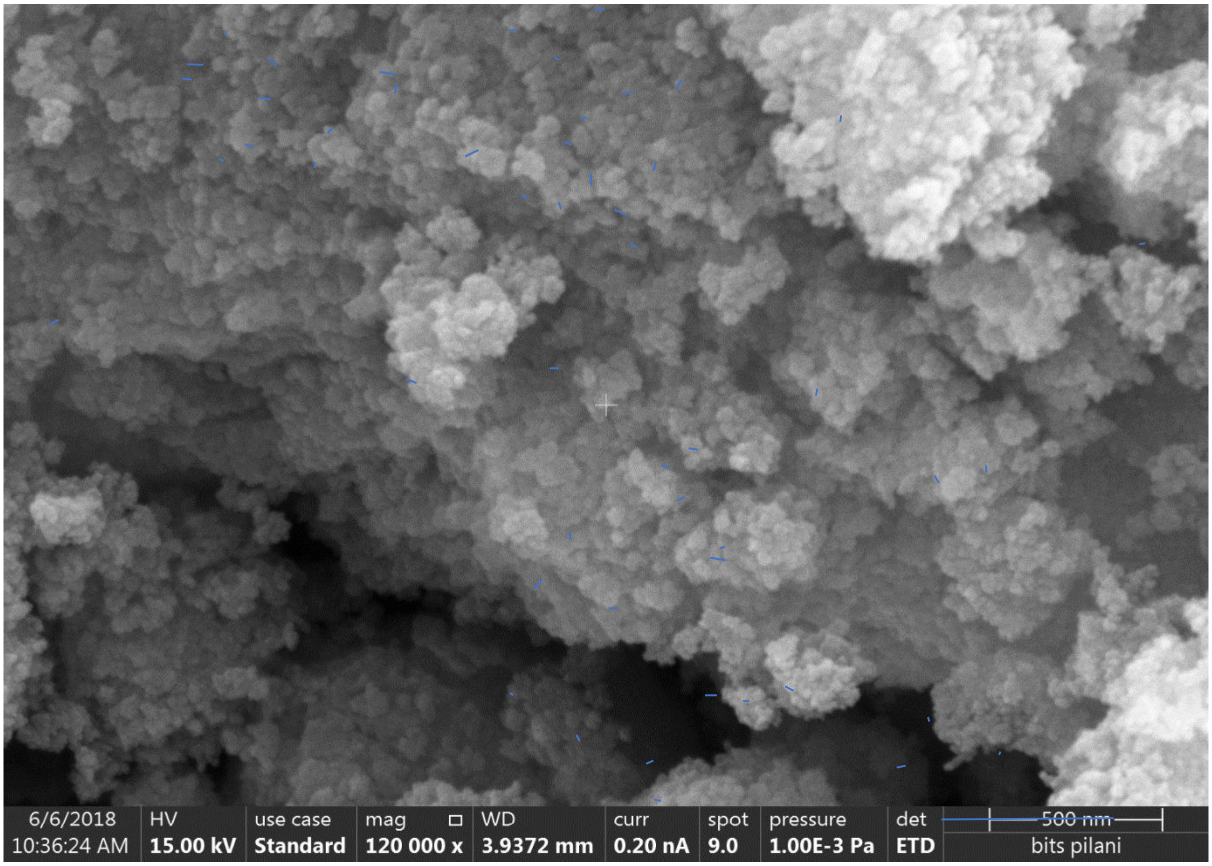
$$Particle\ Size\ (PS) = \frac{Actual\ Size * Unit\ Scale}{\text{Unit Size}}$$

Appendix Table 1. Manual calculation of Particle Size using the scale obtained from SEM image of Fe^0

AS	AS*US	PS	AS	AS*US	PS	AS	AS*US	PS	AS	AS*US	PS
0.07	35	15.4	0.07	35	15.4	0.05	25	11.0	0.04	20	8.8
0.08	40	17.5	0.12	60	26.3	0.09	45	19.7	0.08	40	17.5
0.09	45	19.7	0.1	50	21.9	0.08	40	17.5	0.07	35	15.4
0.07	35	15.4	0.06	30	13.2	0.16	80	35.1	0.06	30	13.2
0.09	45	19.7	0.02	10	4.4	0.15	75	32.9	0.13	65	28.5
0.12	60	26.3	0.06	30	13.2	0.06	30	13.2	0.09	45	19.7
0.07	35	15.4	0.04	20	8.8	0.15	75	32.9	0.12	60	26.3
0.11	55	24.1	0.07	35	15.4	0.09	45	19.7	0.08	40	17.5
0.08	40	17.5	0.09	45	19.7	0.09	45	19.7	0.07	35	15.4
0.07	35	15.4	0.14	70	30.7	0.02	10	4.4	0.05	25	11.0
0.07	35	15.4	0.12	60	26.3	0.05	25	11.0	0.09	45	19.7
0.04	20	8.8	0.06	30	13.2	0.08	40	17.5	0.08	40	17.5
0.09	45	19.7	0.05	25	11.0	0.12	60	26.3	0.12	60	26.3
0.09	45	19.7	0.15	75	32.9	0.09	45	19.7	0.09	45	19.7
0.09	45	19.7	0.04	20	8.8	0.12	60	26.3	0.13	65	28.5
0.04	20	8.8	0.1	50	21.9	0.09	45	19.7	0.02	10	4.4
0.05	25	11.0	0.07	35	15.4	0.08	40	17.5	0.09	0.09	0.0
0.08	40	17.5	0.09	45	19.7	0.07	35	15.4	0.13	65	28.5
0.16	80	35.1	0.08	40	17.5	0.12	60	26.3	0.12	60	26.3
0.07	35	15.4	0.06	30	13.2	0.16	80	35.1	0.09	45	19.7
0.09	45	19.7	0.13	65	28.5	0.21	105	46.1	0.08	40	17.5
0.06	30	13.2	0.12	60	26.3	0.07	35	15.4	0.06	30	13.2
0.02	10	4.4	0.11	55	24.1	0.09	45	19.7	0.06	30	13.2
0.07	35	15.4	0.09	45	19.7	0.04	20	8.8	0.09	45	19.7
0.04	20	8.8	0.11	55	24.1	0.08	40	17.5	0.09	45	19.7
0.07	35	15.4	0.11	55	24.1	0.12	60	26.3	0.11	55	24.1
0.12	60	26.3	0.09	45	19.7	0.14	70	30.7	0.13	65	28.5
0.06	30	13.2	0.06	30	13.2	0.12	60	26.3	0.13	65	28.5

Note: AS-Actual Size, US-Unit Scale, PS-Particle Size

4.3 Fe_3O_4



Appendix Fig.5. Calculation of particle size of Fe_3O_4 using the scale obtained from SEM image.

Appendix Table 2. Manual calculation of Particle Size using the scale obtained from SEM image of Fe_3O_4

AS	AS*US	PS
0.22	110	47.8
0.06	30	13.0
0.15	75	32.6
0.12	60	26.1
0.11	55	23.9
0.13	65	28.3
0.14	70	30.4
0.13	65	28.3
0.15	75	32.6
0.25	125	54.3
0.15	75	32.6
0.13	65	28.3
0.15	75	32.6
0.13	65	28.3
0.21	105	45.7
0.13	65	28.3
0.15	75	32.6
0.19	95	41.3
0.15	75	32.6
0.16	80	34.8
0.12	60	26.1
0.16	80	34.8
0.11	55	23.9
0.12	60	26.1
0.13	65	28.3
0.21	105	45.7
0.22	110	47.8
0.19	95	41.3
0.14	70	30.4
0.08	40	17.4

AS	AS*US	PS
0.18	90	39.1
0.21	105	45.7
0.15	75	32.6
0.13	65	28.3
0.15	75	32.6
0.07	35	15.2
0.22	110	47.8
0.11	55	23.9
0.17	85	37.0
0.08	40	17.4
0.09	45	19.6
0.13	65	28.3
0.22	110	47.8
0.06	30	13.0
0.07	35	15.2
0.16	80	34.8
0.12	60	26.1
0.13	65	28.3
0.07	35	15.2
0.14	70	30.4
0.08	40	17.4
0.06	30	13.0
0.12	60	26.1
0.11	55	23.9
0.08	40	17.4
0.12	60	26.1
0.12	60	26.1
0.18	90	39.1
0.05	25	10.9
0.07	35	15.2

AS	AS*US	PS
0.08	40	17.4
0.12	60	26.1
0.14	70	30.4
0.15	75	32.6
0.2	100	43.5
0.16	80	34.8
0.12	60	26.1
0.18	90	39.1
0.2	100	43.5
0.12	60	26.1
0.04	20	8.7
0.22	110	47.8
0.11	55	23.9
0.11	55	23.9
0.12	60	26.1
0.11	55	23.9
0.1	50	21.7
0.16	80	34.8
0.15	75	32.6
0.12	60	26.1
0.11	55	23.9
0.08	40	17.4
0.13	65	28.3
0.09	45	19.6
0.14	70	30.4
0.07	35	15.2
0.14	70	30.4
0.15	75	32.6
0.12	60	26.1
0.12	60	26.1

AS	AS*US	PS
0.07	35	15.2
0.09	45	19.6
0.13	65	28.3
0.05	25	10.9
0.11	55	23.9
0.15	75	32.6
0.13	65	28.3
0.06	30	13.0
0.15	75	32.6
0.2	100	43.5
0.22	110	47.8
0.18	90	39.1
0.07	35	15.2
0.11	55	23.9
0.09	45	19.6
0.16	80	34.8
0.13	65	28.3
0.12	60	26.1
0.09	45	19.6
0.05	25	10.9
0.16	80	34.8
0.13	65	28.3
0.13	65	28.3

Note: AS-Actual Size, US-Unit Scale, PS-Particle Size