Nanofluids: A New Generation Coolants

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Abstract

The objective proposed is to test a mini heat transfer test rig by providing the nanofluids as an efficient coolant that can be used in a liquid cooling system. A model was built from the components in a CPU liquid cooling system which consists of water block, heat exchanger, liquid pump, reservoir tank and tubes which run using the direct current. The thermal analysis then was conducted by observed the temperature difference of the water block. The resulting result shows that there is the reduction in the observed temperature of the water block. It can be concluded that this model is able to perform the intended function successfully and nanofluids was suggested to be used as a coolant.

Novelty

Nanofluids are promising future coolant candidate for thermal management system

Introduction

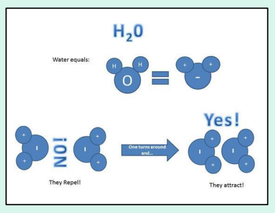
What is Nanofluids?

Nanofluids are suspensions of nano sized particles in the base fluids

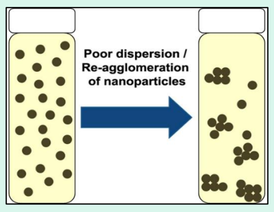
Advantages of Nanofluids

Challenges of Nanofluids

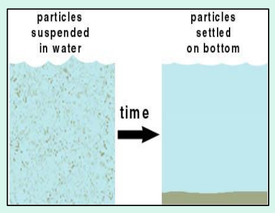
Hydrophobicity



Dispersion



Sedimentation



Materials & Method

Why use CNT/CNF?

Excellent mechanical, electrical and thermal properties

Table 1 Physical properties of CNT/CNF

Properties	CNF	CNT
CNT Type	Carbon Nanofiber	Carbon Nanotube
Manufacturer	Pyrograf Products	Nanoamor
Density	2.0 g/cm^3	2.1 g/cm^3
Purity	>98 %	>90 %
Diameter	100nm	10-30nm
Color	Black	Black
Form	Powder	Powder

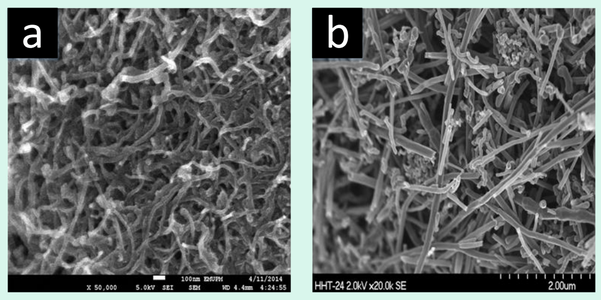
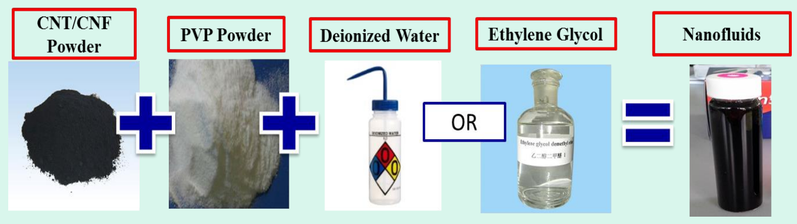
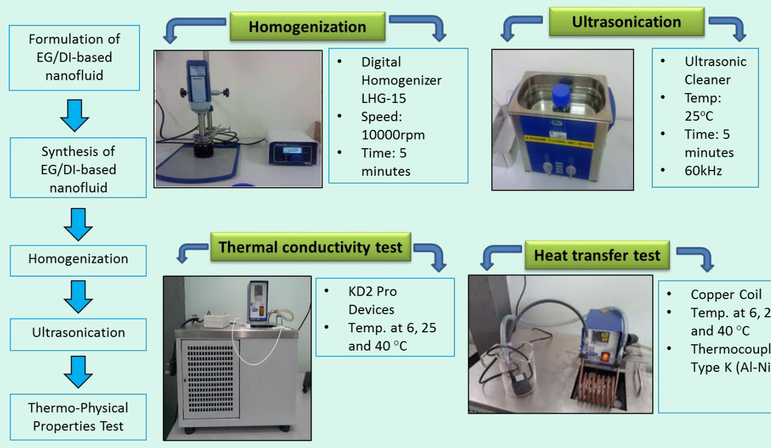


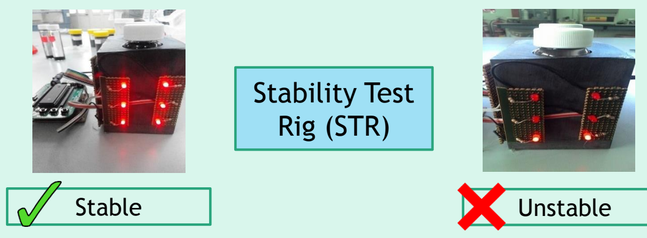
Figure 1 Characterization a) CNT and b) CNF using FESEM

Nanofluids Preparation





How to check homogenous nanofluids?



Results & Discussion

Table 2 Thermal conductivity enhancement of a) CNF-EG b) CNT-EG c) CNF-DI and d) CNT-DI based fluid

(a)

CNF (wt%)	Percentage of Enhancement (%) at Temperature (°C)		
	6	25	40
0.1	5.79	1.83	4.91
0.2	6.76	4.10	5.80
0.3	2.42	9.13	0.89
0.4	1.93	-1.10	0.45
0.5	2.42	19.18	1.79
0.6	29.95	20.09	12.95
0.7	8.69	3.20	20.98
0.8	11.11	9.13	16.51
0.9	8.21	14.15	10.27
1.0	15.45	45.66	16.52

(b)

CNT (wt%)	Percentage of Enhancement (%) at Temperature (°C)		
	6	25	40
0.1	9.95	2.51	0.00
0.2	13.30	5.24	0.04
0.3	14.89	5.56	2.85
0.4	15.50	7.06	4.32
0.5	12.70	3.55	3.88
0.6	16.60	8.56	6.24
0.7	14.60	6.92	5.35
0.8	14.60	11.62	9.67
0.9	16.60	11.16	11.01
1.0	20.10	13.12	14.27

(c)

CNF (wt%)	Percentage of Enhancement (%) at Temperature (°C)		
	6	25	40
0.1	1.09	2.10	-1.68
0.2	4.12	5.82	-8.74
0.3	7.63	0.35	-14.28
0.4	5.47	4.20	-10.92
0.5	9.18	8.24	-11.93
0.6	10.04	6.14	3.36
0.7	10.18	5.80	5.54
0.8	12.16	4.90	7.56
0.9	18.45	11.75	11.26
1.0	20.17	14.04	15.29

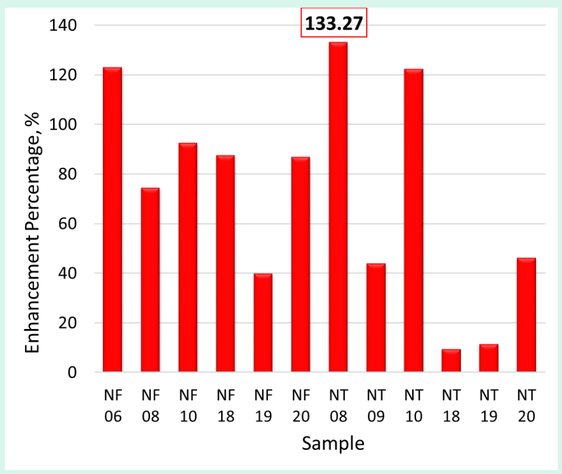
(d)

CNT (wt%)	Percentage of Enhancement (%) at Temperature (°C)		
	6	25	40
0.1	1.48	1.98	2.69
0.2	3.68	2.23	8.74
0.3	1.43	0.18	-1.69
0.4	4.04	5.04	-22.35
0.5	3.15	4.39	-7.61
0.6	3.86	1.11	0.84
0.7	3.04	3.04	-10.86
0.8	4.35	4.56	-9.96
0.9	4.83	5.21	-7.89
1.0	6.80	7.77	-29.12

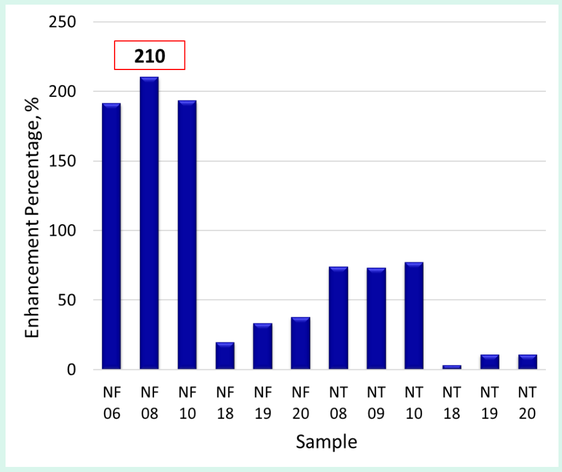
Table 3 Sample coding

Code	Sample
NF06	0.6wt% CNF (EG)
NF08	0.8wt% CNF (EG)
NF10	1.0wt% CNF (EG)
NF18	0.8wt% CNF (DI)
NF19	0.9wt% CNF (DI)
NF20	1.0wt% CNF (DI)
NT08	0.8wt% CNT (EG)
NT09	0.9wt% CNT (EG)
NT10	1.0wt% CNT (EG)
NT18	0.8wt% CNT (DI)
NT19	0.9wt% CNT (DI)
NT20	1.0wt% CNT (DI)

(a)



(b)



(c)

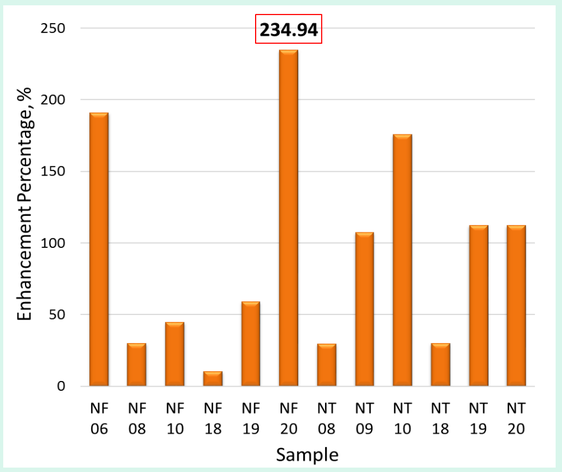


Figure 2 Heat transfer percentage enhancement at a) 6 °C b) 25 °C and c) 40 °C

Conclusion

Nanofluids formulated shows several improvements in terms of percentage enhancement as compared to the standard mixture of ethylene glycol and deionized water. Nanofluids are expected to be a promising coolant candidate for thermal management system of next generation high heat dissipation electronic systems.

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