A study of Ordering-Disordering state and the dynamic properties of colloidal particles on 2D Periodic Substrate system

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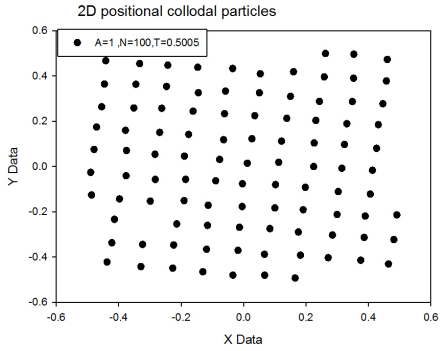

FIG. 1. The colloid configurations (black dots) for a square 2D periodic substrate with substrate strength equal to 1,number of colloid equal to 100 at T=0.5005KT.

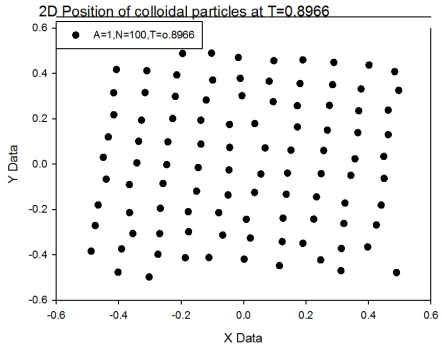

FIG. 2. The colloid configurations for a square 2D periodic substrate with substrate strength equal to 1,number of colloid equal to 100 at T=0.8966KT.

A rich variety of novel statistical properties and ordering-disordering states colloidal particle interacting through a long range repulsive Yukawa potential, confined by a 2D periodic substrate potential is investigated[1],[2],[3],[4].

The study of ordering of colloidal particles and the variation of the statistical quantities of them resemble that of a KBT-like defect topological in low temperature phase Fig. 1, Fig. 2[5],[6]. We found a strong dependence of the substrate strength on arrangement of the particles and the diffusive behavior of them[7] .We study the equilibrium properties such as order parameter, potential per energy and heat capacity through a Monte Carlo simulation Fig. 3,Fig. 4,Fig. 5,Fig. 6,Fig. 7,Fig. 8. The evolution of the correlation function for different temperatures is also studied Fig. 9. In addition, we studied the dynamic properties of particles structure through a MD simulation[8], which cannot provide by equilibrium sampling method. Specifically, we studied the fluctuation of velocity and instantaneous temperature of particles vs time-stepsFig. 10. By studying of these quantities, We, finally come to an equilibrium steady state system, which is completely dependent to the substrate strength and density of particles.

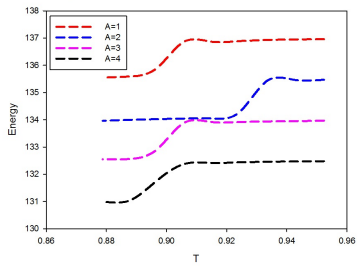

FIG. 3. The variation of potential energy of colloidal particles vs Temperature for different substrate strength in low temperature phase.

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[1] C.Reichhardt and C.J.Olson Phys.Rev.Lett **88**, 248301(2002).

[2] C.Reichhardt and C.J.Olson Reichhardt Europhys.Lett **68**, 303(2004) .

[3] A.Libal , C.Reichhardt and C.J.Olsont Phys.Rev.E **75**, 011403(2007).

[4] Amin Najafi, *J. Phys.: Conf. Ser* **510**, 012025(IOP),(2014).

[5] Kosterlitz J.M.,Thouless D.J J.Phys.C **5**, L124(1972) .

[6] Kosterlitz J.M.,Thouless D.J J.Phys.C **5**, 1181(1973)

[7] J. C. N. Carvalho,K. Nelissen, W. P. Ferreira, G. A. Farias, and F. M. Peeters Phys.Rev.E **85**, 021136 (2012) .

[8] Michael P. Allen *Introduction to Molecular Dynamics Simulation*,(2004) .

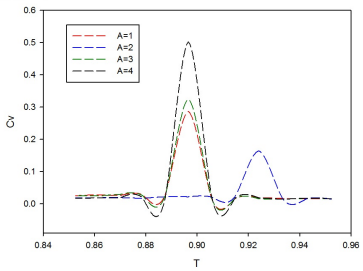

FIG. 4. The variation of heat capacity of colloidal particles vs temperature for different substrate strength in low temperature phase.

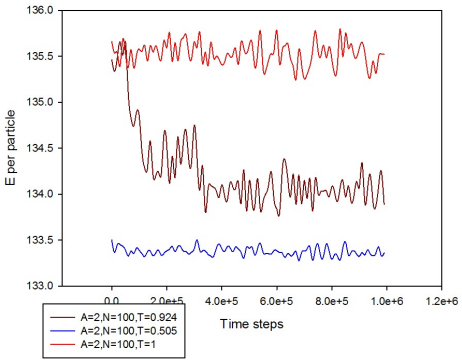

FIG. 5. Comparison of potential energy per particle vs time steps for substrate strength equal to 2 at different temperatures

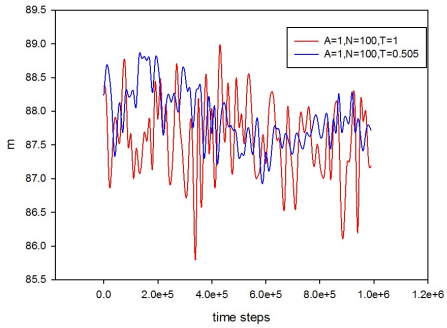

FIG. 6. Comparison of the variation of order parameter vs time steps at high and low temperature.

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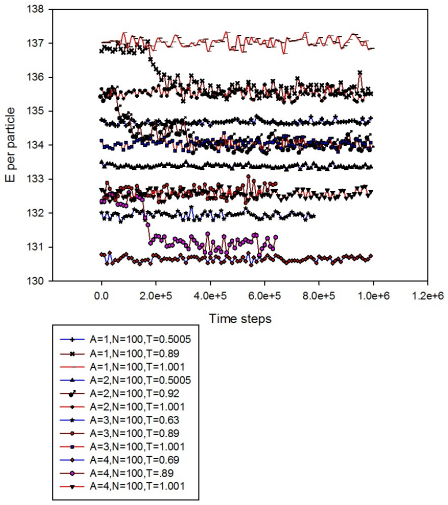

FIG. 7. Comparison of potential energy per particle vs time steps for different substrate strength at different temperatures.

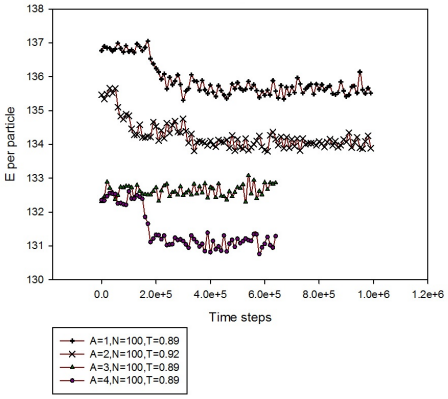

FIG. 8. Comparison of potential energy per particle vs time steps for different substrate strength at critical temperatures.

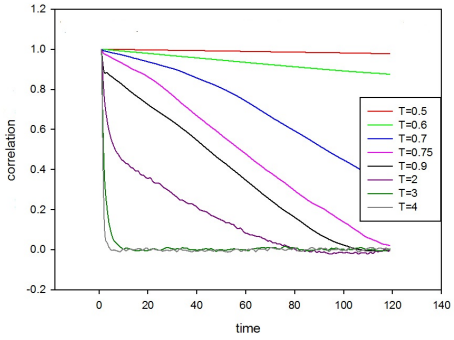

FIG. 9. The variation of correlation function at different temperatures.

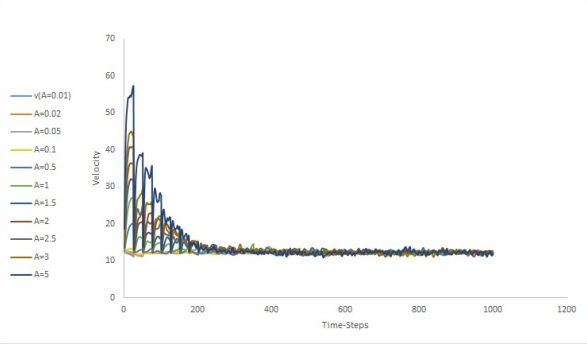

FIG. 10. The fluctuation of velocity of colloidal particles at different substrate strength.