

Simulation of Piezo Electrically Actuated Drug Delivery Device for Bio Medical Application

Joyline Dsa¹, Manisha¹, M. Goswami¹, B.R. Singh¹

1. Indian Institute of Information Technology Allahabad, U.P, India

Introduction: Drug Delivery System is one of the most promising aspect of Bio-MEMS technology. Essentially, DDS refers to a particular way of administering a drug to the patient. We have developed a peizo electrically controlled MEMS drug delivery device for on-demand release of defined quantities

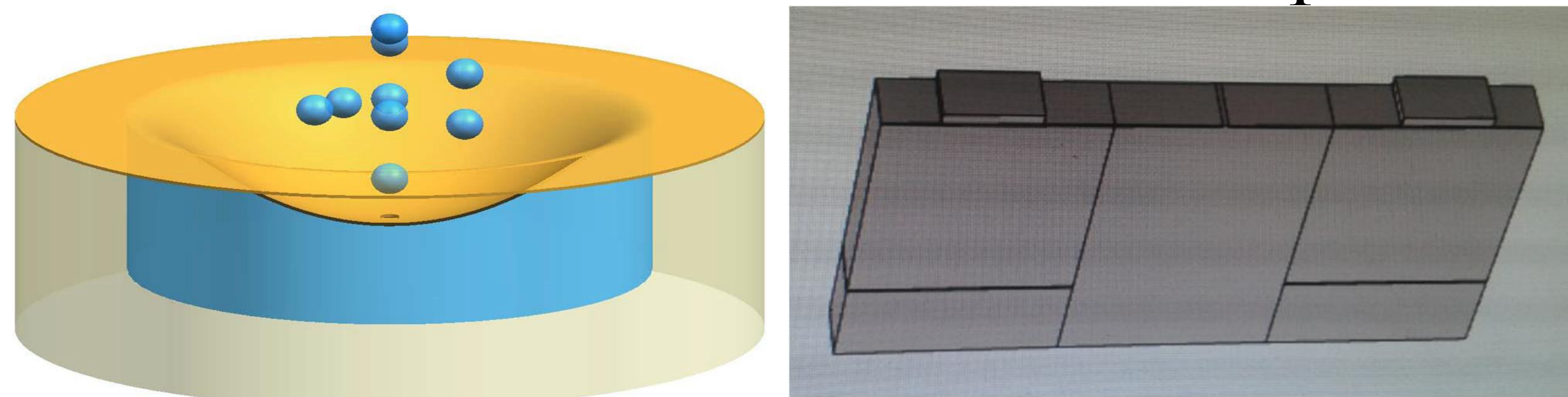


Figure 1. Piezoelectrically actuated drug delivery device **Figure 2.** Geometry of the defined structure

Results: The rate of drug flow can be controlled by adjusting the thickness of piezoelectric material and also by varying the electric potential. The direction of deflection can be controlled by the electric field and by adjusting the polarization of atoms of PZT.

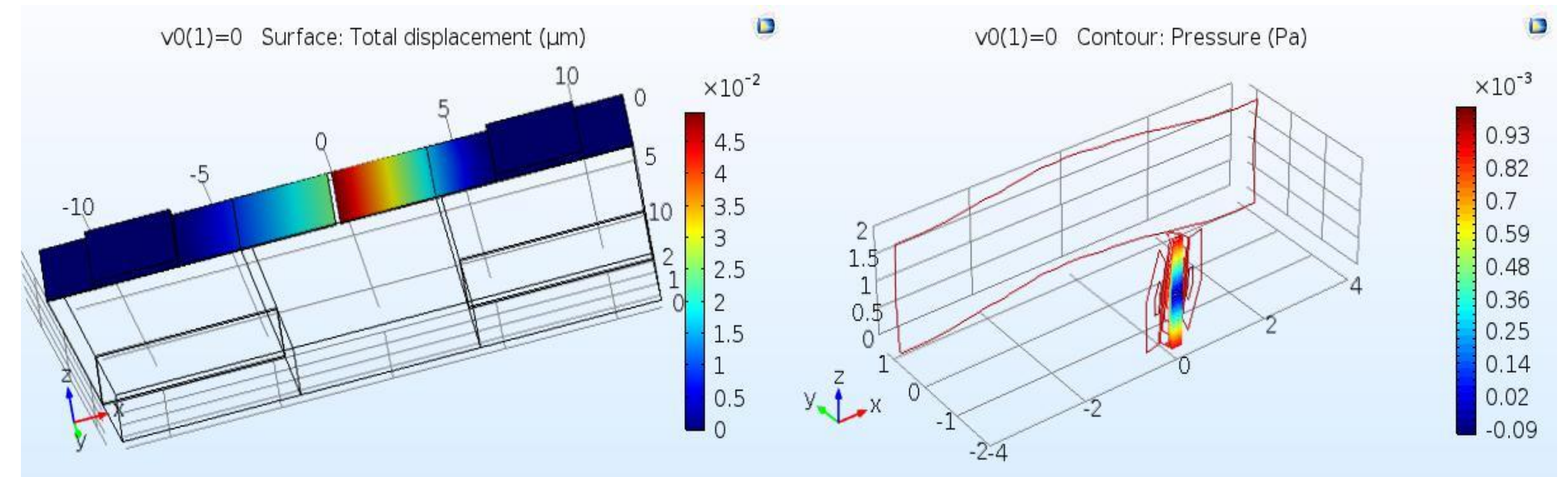


Figure 3. Total displacement on application of 5V

Figure 4. Pressure developed due to the force exerted on membrane

Computational Methods:

Physics used	Equation	Description
Electrostatic	$E = -\nabla V$ $\nabla \cdot D = \rho v$	E=Young's modulus D=Electric Displacement
Laminar Flow	$\rho(u_2 \cdot \nabla)u_2 = \nabla \cdot [p21 + \mu(\nabla u_2 + (\nabla u_2)^T)] + F$ $\rho \nabla \cdot (u_2) = 0$	μ =dynamic viscosity of the material u_2 =velocity field

Table1:physics governing the proposed design

Property	Value	units
Density (PDMS)	970	Kg/m3
Density (PZT)	6650	Kg/m3
Poisson's Ratio (PDMS)	0.5	1
Young's Modulus(PDMS)	750[k]	Pa
Relative permittivity (PZT)	{919.1,919.1,826.6}	1
Density of liquid	1e3	Kg/m3
Dynamic Viscosity of liquid	1e3	Pa.s

Table1:material properties

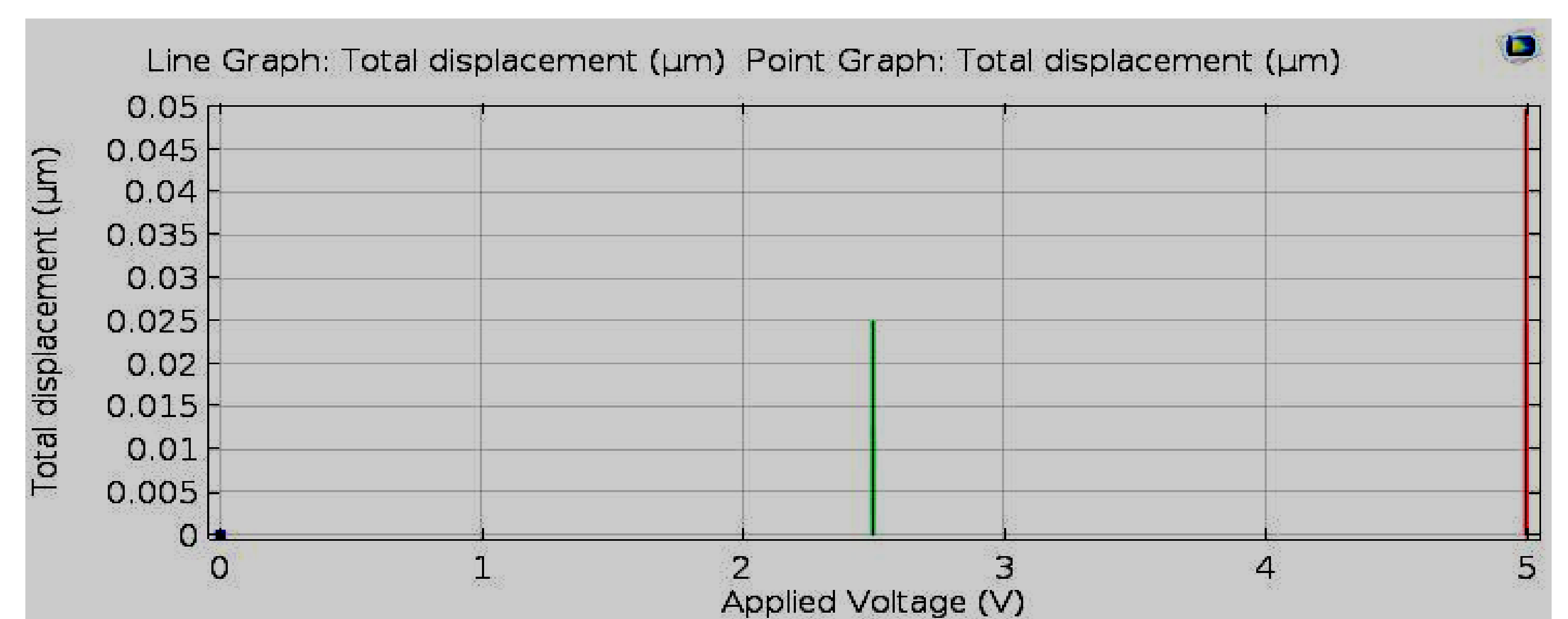


Figure 5. Above graph concludes that the increase in electric field results in increase in the displacement of membrane

Conclusion: Advances in drug delivery systems have increasingly brought about controlled and increased efficacy and constant drug delivery. The simulation of these type of devices will lead to an effective study of the drug release on to the targeted sites.

References:

- 1) R.S. Shawgo, A.C.R. Grayson, Y. Li, et M.J. Cima, "BioMEMS for drug delivery", Current Opinion in Solid State and Materials Science, vol. 6, pp. 329-334, 2002.
- 2) Qifeng Cui, Chengliang Liu, Xuan F. Zha, "Study on a piezoelectric micropump for the controlled drug delivery system", Microfluid Nanofluid 3, , pp. 377-390 ,2007.