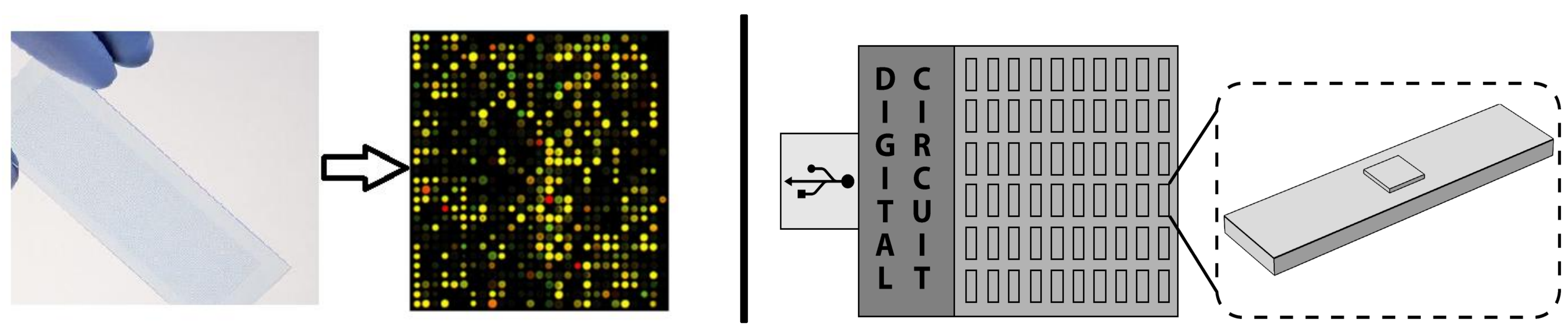
A Novel Plug N Play MEMS-Based DNA Microarray

K. Jindal[1], V. Grover[2], B. Nayak[3]

1. Dept. of Biological Sciences, Birla Institute of Technology and Science, Pilani, Rajasthan, India
2. Dept. of Mechanical Engineering, Birla Institute of Technology and Science, Pilani, Rajasthan, India
3. Dept. of Electronics & Electrical Engg., Birla Institute of Technology and Science, Pilani, Rajasthan, India

Conventional Microarrays | **MEMS based Microarrays**



Conventional Microarrays	MEMS based Microarrays
Expensive reagents	*Cheaper*
Complex instrumentation	*Direct interface to PC*
More steps	*Direct sensing, lesser steps*

Introduction: Microarrays are a widely popular tool in biological research, typically used for discerning expression pattern of a large number of genes in a given cell sample at once. At its core, it is basically an array of tiny DNA sensors. Previously, reported MEMS based DNA sensors are not practically usable in microarrays due to various reasons such as lack of scalability, high noise, low reliability across cantilevers[1][2]. In this study, we try to address these issues and simulate a MEMS based DNA sensor in the COMSOL Multiphysics software.

Methodology: A mass based resonant sensor was simulated in COMSOL Multiphysics. Mechanical vibrations were converted to an AC voltage signal using a piezoelectric transducer. This signal was fed to a low noise circuit which extracted the signal frequency and converted it into digital data.
Capacitive actuation was used to initiate resonance. Parameters for capacitive actuation were calculated using the following equations [3]:

$$V_{AC} = \left(\frac{d_{31}Yb}{C}\right)\int_l \varepsilon_1 dx$$

$$\varepsilon_1 = \frac{3F}{YbH^2}\left[1 - \frac{x}{l}\right] \text{ and } F = \frac{\varepsilon_0 A V_{AC} V_{DC}}{d^2}$$

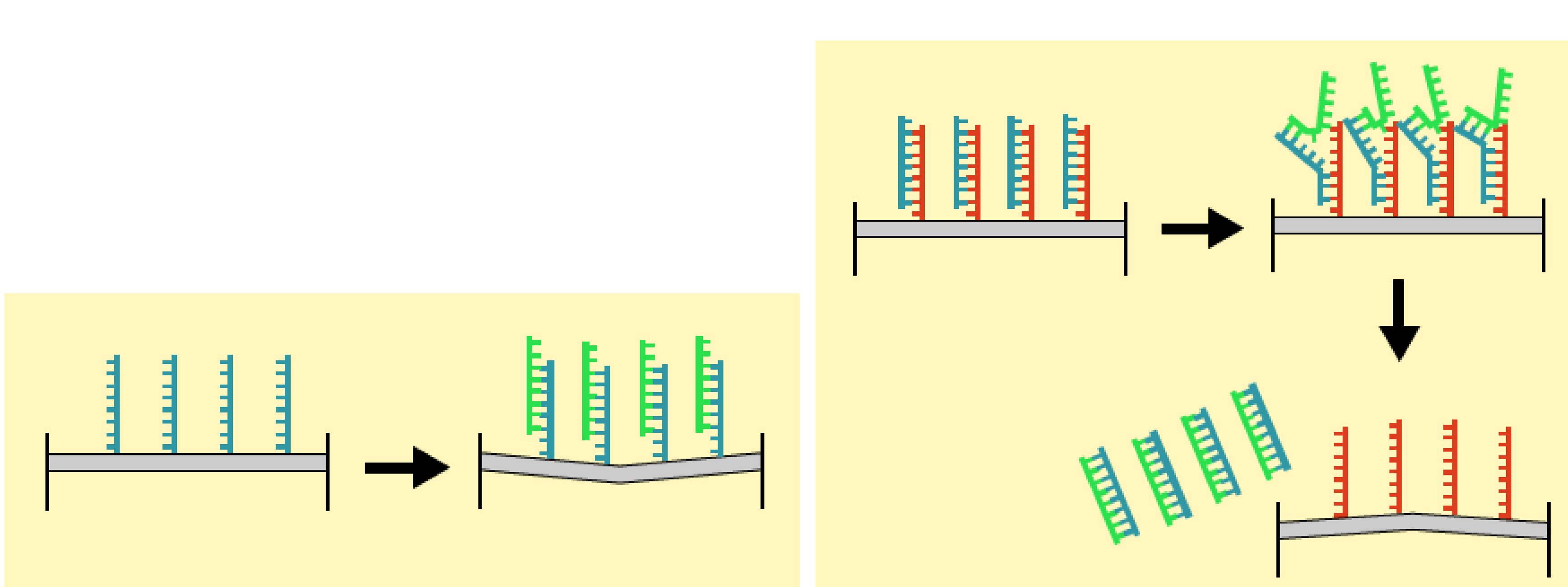


Figure 1. Setup of a traditional DNA sensor versus the DNA strand displacement approach.

Results:

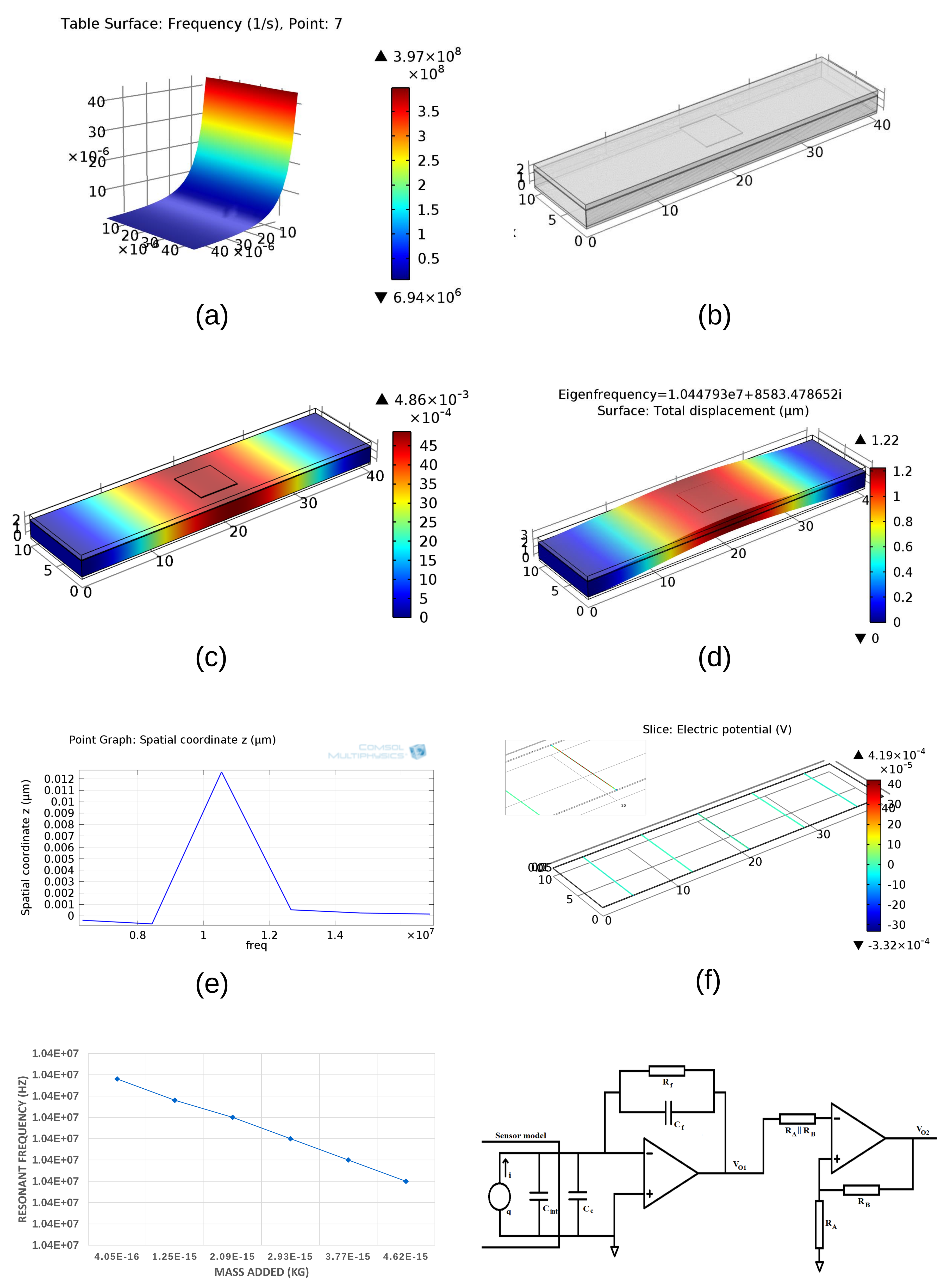


Figure 2. Simulation results of the sensor. (a) Determination of dimensions. (b) Sensor model. (c) Stationary study. (d) Eigenfrequency study. (e) Frequency sweep. (f) Piezoelectric stationary study. (g) Sensor response. (h) Downstream circuit

Conclusion: The study demonstrates simulation of a functioning linear MEMS based DNA sensor with tunable sensitivity. We feel that such a device, if implemented successfully would be very useful in making microarray technology available to a wider group of researchers.

References:
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