

MULTIPHYSICS MODELING AND SIMULATION OF MEMS BASED BOLOMETER FOR DETECTING THE RADIATIONS IN NUCLEAR POWER PLANTS

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SYNOPSIS

- **INTRODUCTION**
- **ACTUATING METAL PLATES**
- **DESIGN CONCEPT**
- **SIMULATION**
- **RESULT**
- **CONCLUSION**

OBJECTIVE

- **TO DEVELOP A MEMS BASED SENSOR FOR DETECTING NUCLEAR RADIATION.**

INTRODUCTION

- **Nuclear reactors produce large quantities of ionizing radiation.**
- **Their energy is high enough to ionize molecules.**
- **Exposure to ionizing radiation causes damage to living tissue.**

INTRODUCTION

- **So it is important to detect their presence.**
- **This paper gives the design and simulation of MEMS based sensor to detect those hazardous radiation.**



ACTUATING METAL PLATES

- **Form potential applications for large and linear displacements**
- **Micro plates- Different coefficient of thermal expansion (CTE)**
- **Temperature excursions causes deflection**

THERMAL PROPERTIES

PROPERTY	ALUMINIUM	TUNGSTEN
Thermal conductivity	160[W/mK]	173[W/mK]
Heat capacity	900[J/kg*K]	1340[J/kg*K]
Coefficient of thermal expansion	23e-6[1/K]	4.5e-6[1/K]
Density	2700[Kg/m^3]	17800[Kg/m^3]

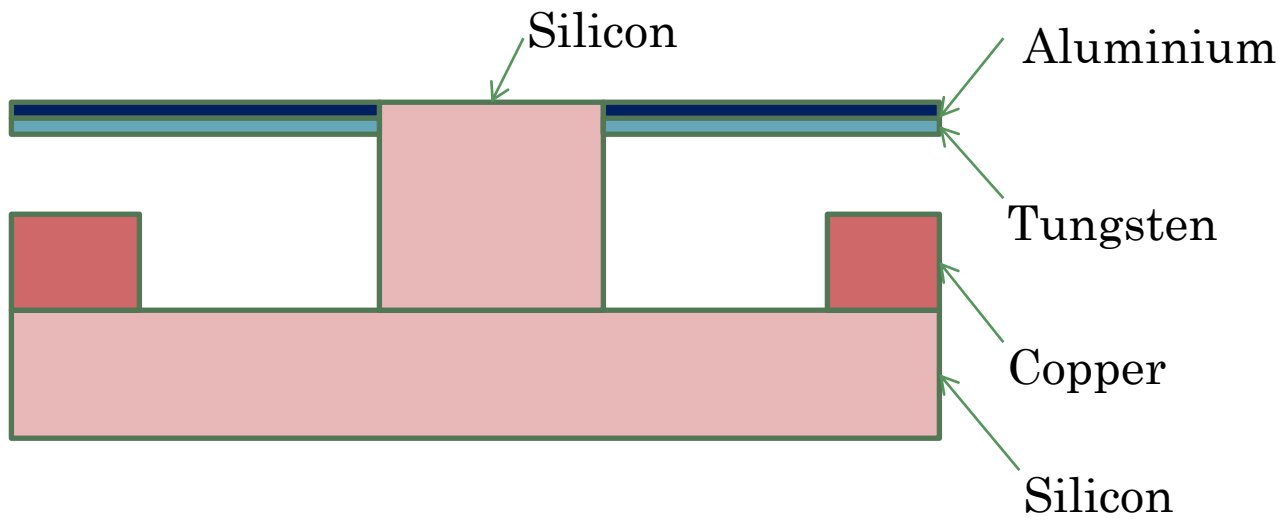
PROPERTY	LEAD	SILVER
Thermal conductivity	35.3[W/mK]	429[W/mK]
Heat capacity	127[J/kg*K]	235[J/kg*K]
Coefficient of thermal expansion	28.9e-6[1/K]	18.9e-6[1/K]
Density	11340[Kg/m^3]	10500[Kg/m^3]



DESIGN CONCEPTS



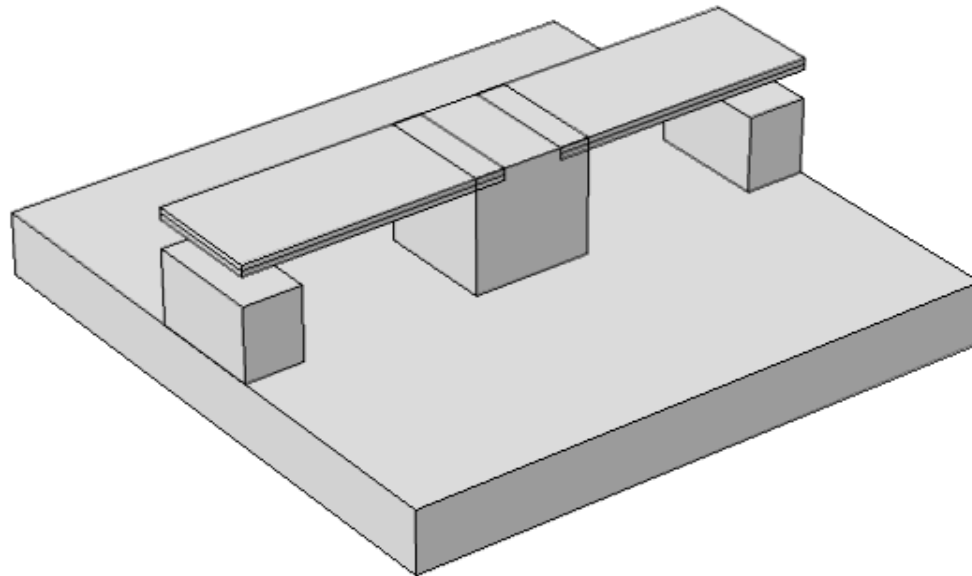
DESIGN



DESIGN PARAMETERS

Parameters	Values(μm)
Width of the substrate	100
Depth of the substrate	100
Height of the substrate	11
Width of the metal plate	45
Depth of the metal plate	20
Height of the metal plate	1
Width of the copper link	10
Depth of the copper link	20
Height of the copper link	13
Width of the central support	20
Depth of the central support	20
Height of the central support	20

GEOMETRY MODEL



SIMULATION

- Software used - COMSOL Multiphysics 4.3
- Physics Applied - Thermal Stress
- Mesh - Free Tetrahedral

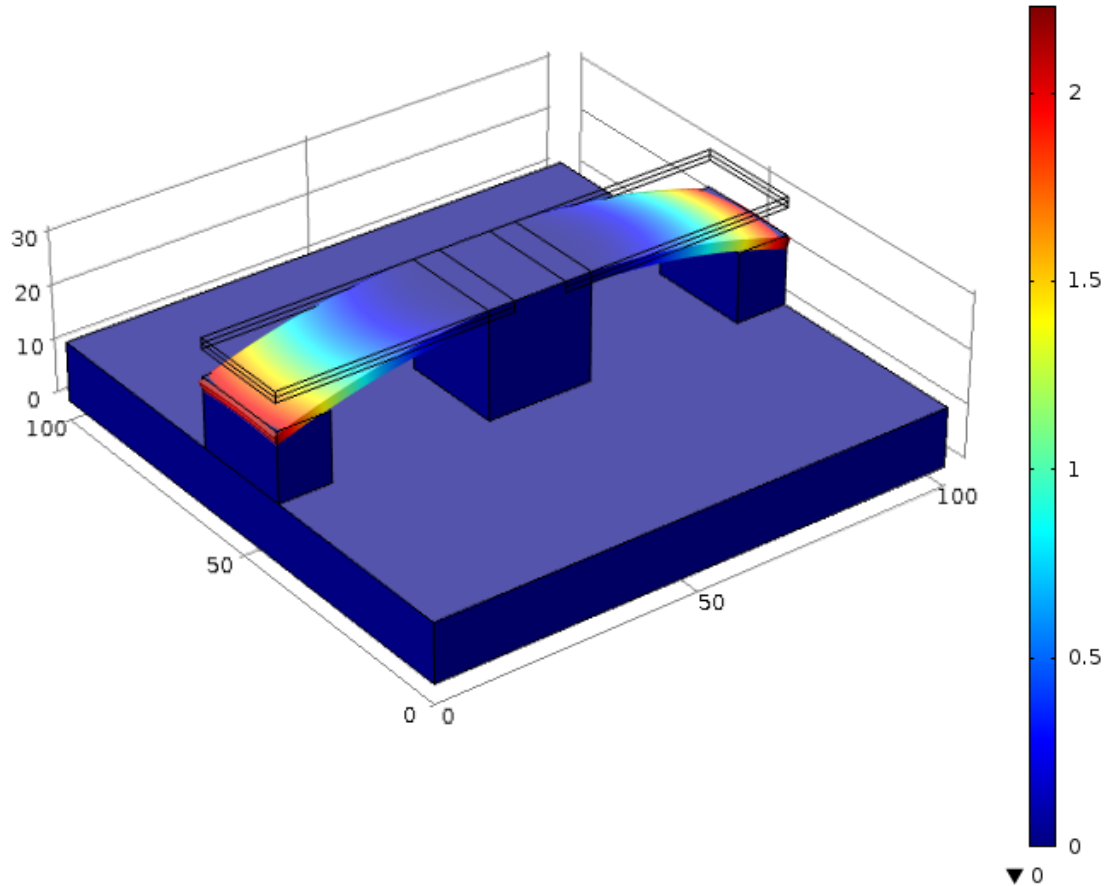


RESULTS AND DISCUSSION

Surface: Total displacement (μm)

COMSOL
MULTIPHYSICS

▲ 2.2247

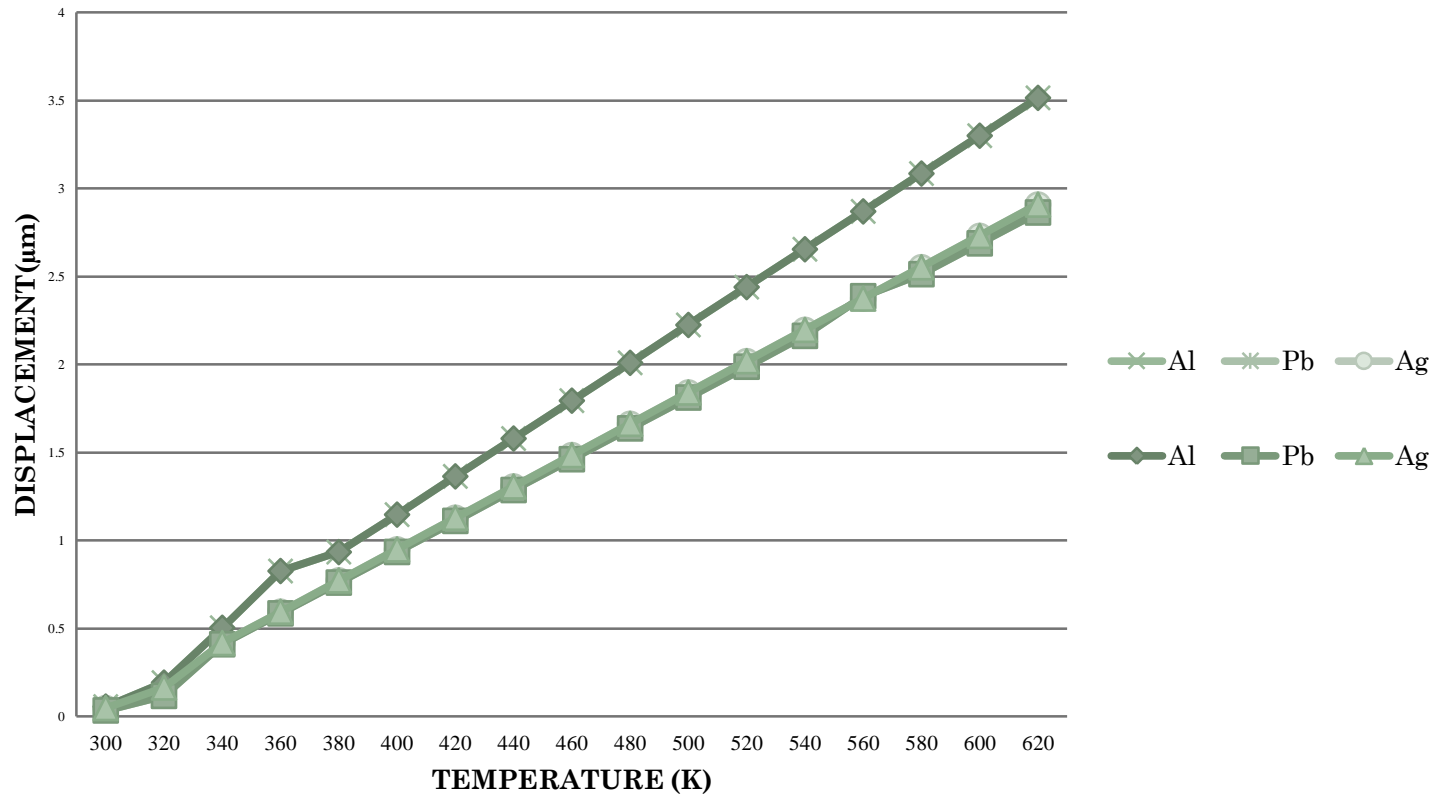


DISPLACEMENT BY VARIOUS METAL PLATES

Temperature (K)	Displacement(μm)		
	Al-W	Pb-W	Ag-W
300	0.0567	0.035	0.0486
320	0.193	0.1176	0.1654
340	0.5045	0.411	0.4178
360	0.827	0.5862	0.5957
380	0.9345	0.7614	0.7736
400	1.1473	0.9352	0.9496
420	1.3646	1.1118	1.1294
440	1.5796	1.287	1.3073
460	1.7947	1.4622	1.4853
480	2.0097	1.6373	1.6632
500	2.2247	1.8125	1.8411
520	2.4398	1.9877	2.019
540	2.6548	2.1629	2.1969
560	2.8698	2.3881	2.3748
580	3.0849	2.5133	2.5528
600	3.2999	2.6885	2.7307



TOTAL DISPLACEMENT



CONCLUSION

- The micro plates exhibit deflection for various temperature ranges.
- Deformation is observed on both sides.
- The metal pairs used were Aluminium-Tungsten, Lead-Tungsten and Silver-Tungsten.
- The model with Aluminium-Tungsten pair exhibited faster response than the other pairs.



REFERENCES

- Michael Foxe, , Gabriel Lopez, Isaac Childres, Romaneh Jalilian, Caleb Roecker, John Boguski, Igor Jovanovic#, and Yong P. Chen# , *Member, IEEE*- Detection of Ionizing Radiation Using Graphene Field Effect Transistors.
- R. Reichle, T. Nishitani, E.R. Hodgson, L.C. Ingesson, E. Ishitsuka, S. Kasai, K.F. Mast, T. Shikama, J.C. Vallet, S. Yamamoto, Radiation hardness test of mica bolometers



A decorative vertical bar on the left side of the slide, consisting of several thin, light green vertical lines of varying widths. To the right of these lines are five solid green circles of different sizes, arranged in a cluster that tapers towards the bottom.

THANK YOU