Modeling of Electro-Thermal Microbolometer for Thermal Imaging

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BACKGROUND

A microbolometer is specific type of uncooled infrared radiation detector used in thermal cameras, which converts the incoming energy into a proportionate electrical signal, which is then amplified, processed and displayed, typically on the thermal camera's LCD viewer.
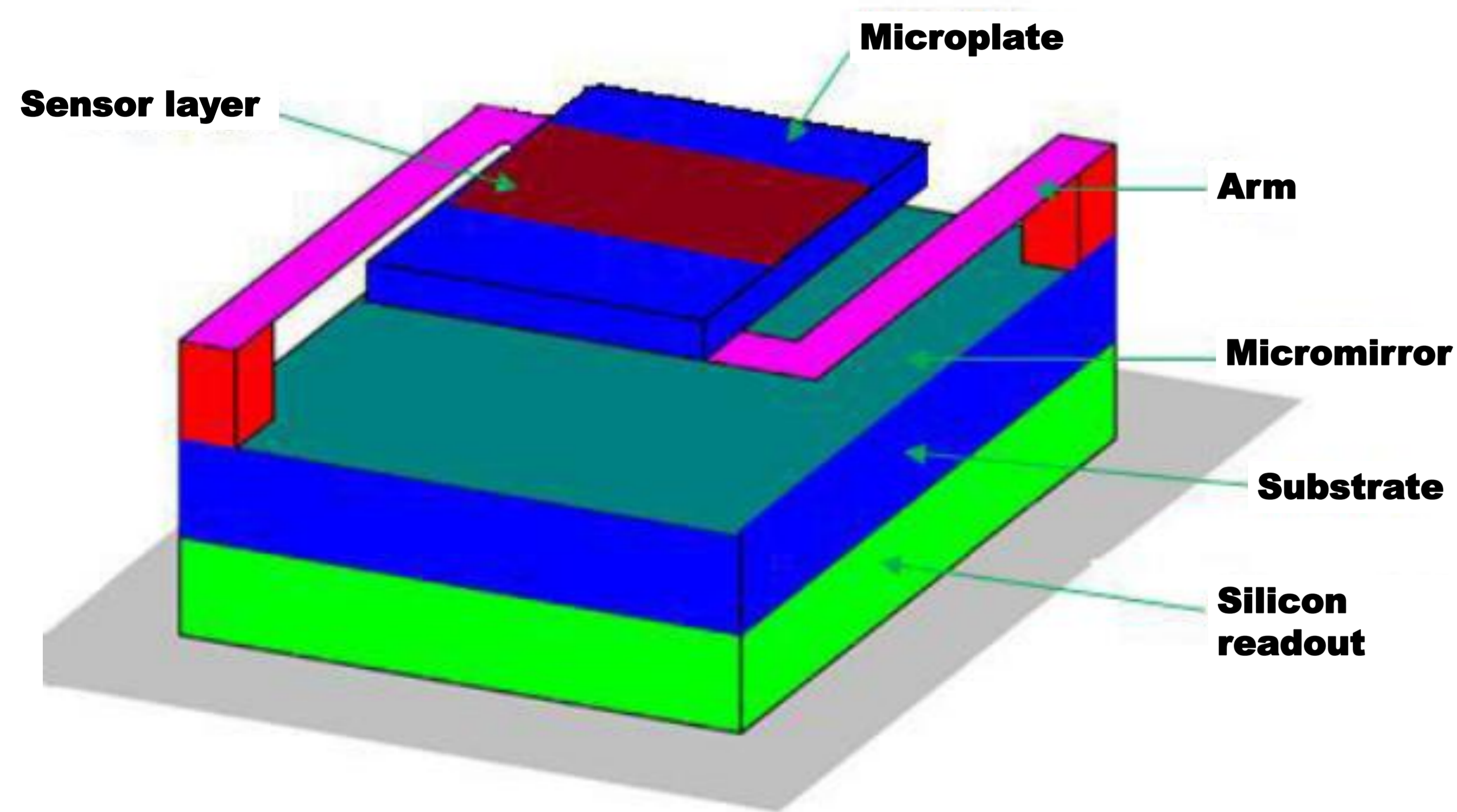

Figure 1 Microbolometer structure

OBJECTIVES

1) Evaluate the responsivity of MEMS (MicroElectroMechanical System) bolometers made of vanadium oxide (VOx) by varying the pixel arm geometries,
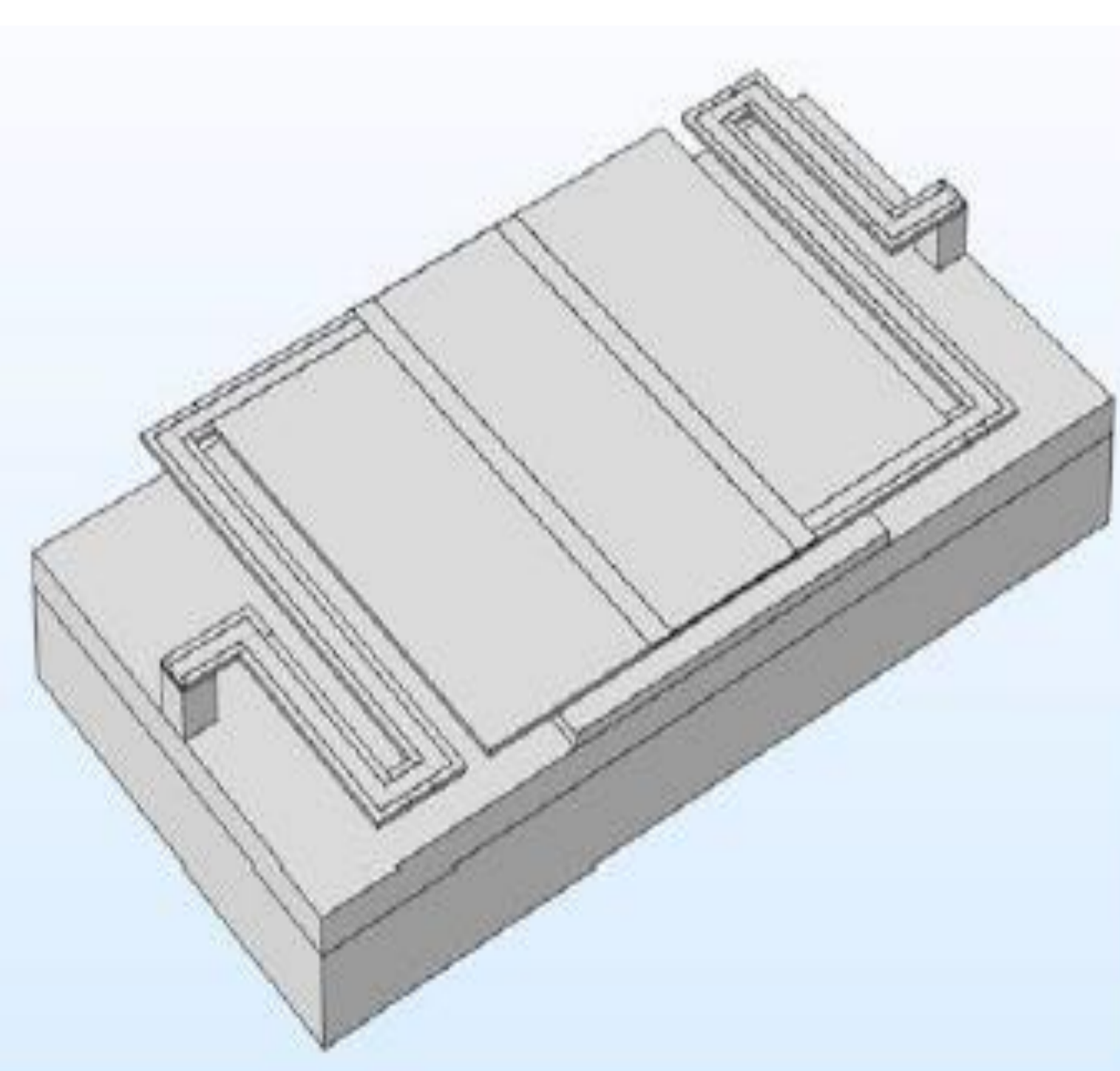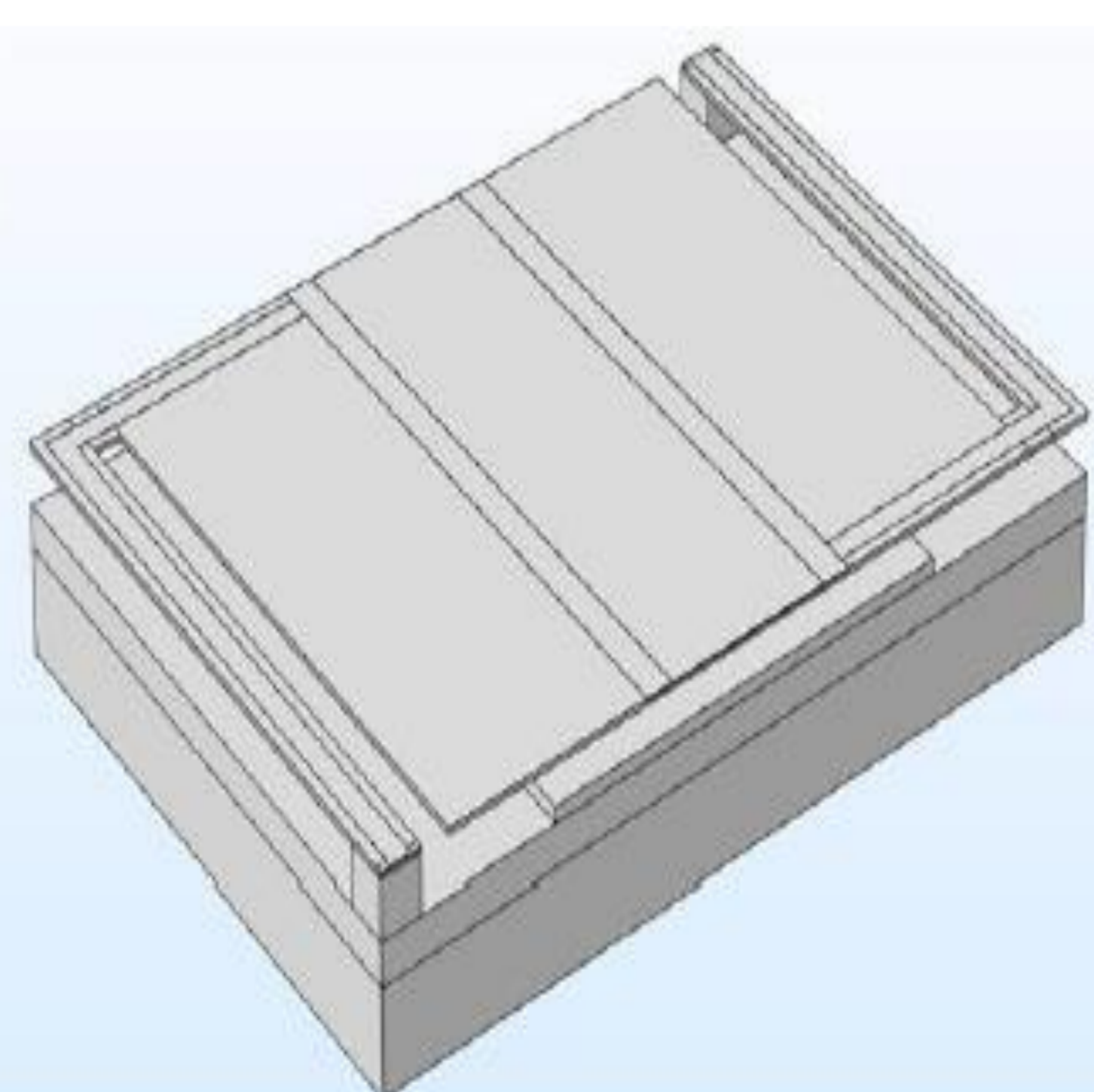

Figure 2 Long-arm geometry   *Figure 3 Short-arm geometry*

2)   Develop a thermo-electrical model of these devices taking into account incoming infrared energy and Joule's heating sources.
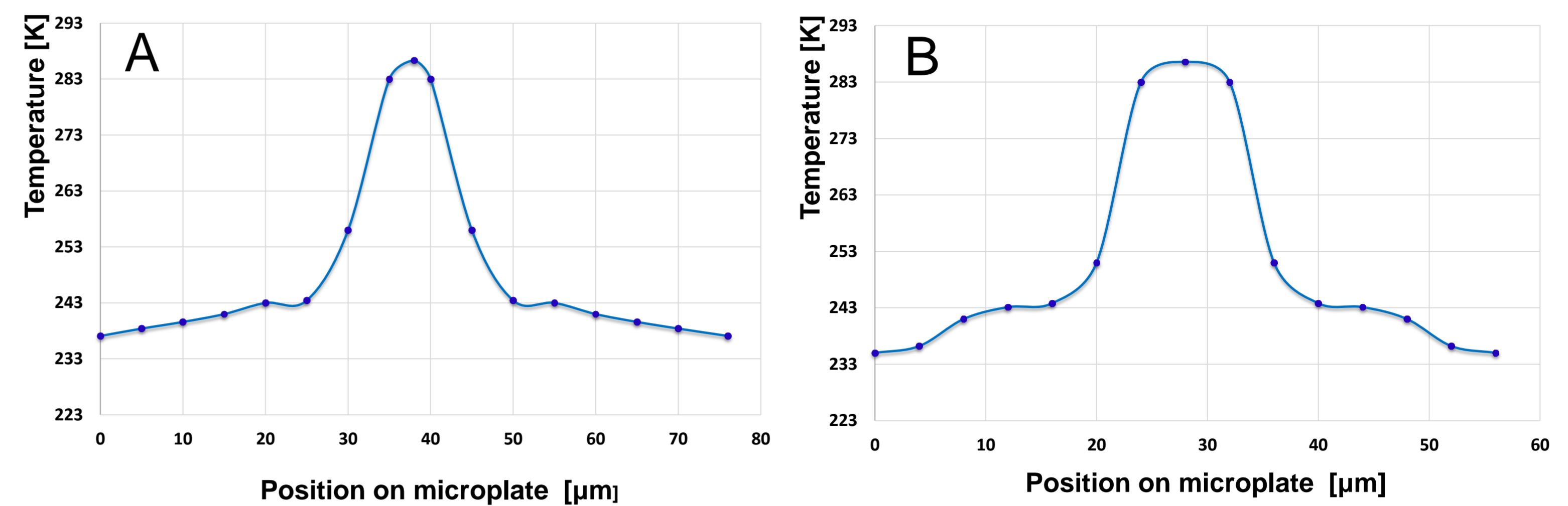
RESULTS and DISCUSSION

Figure 4 Graphical representation Temperature distribution for: a)Long –arm and b)Short –arm geometry

For both geometries the temperature distribution reaches its peak at the centre. This is due to the high electrical resistivity value of VOx legs compared to vanadium legs. This causes a high Joule's heat generation at the centre of the microplate.

• In the long-arm geometry, the temperature decreases quickly which indicates a good thermal insulation of its sensitive layer. This results in a high microbolometer responsivity.
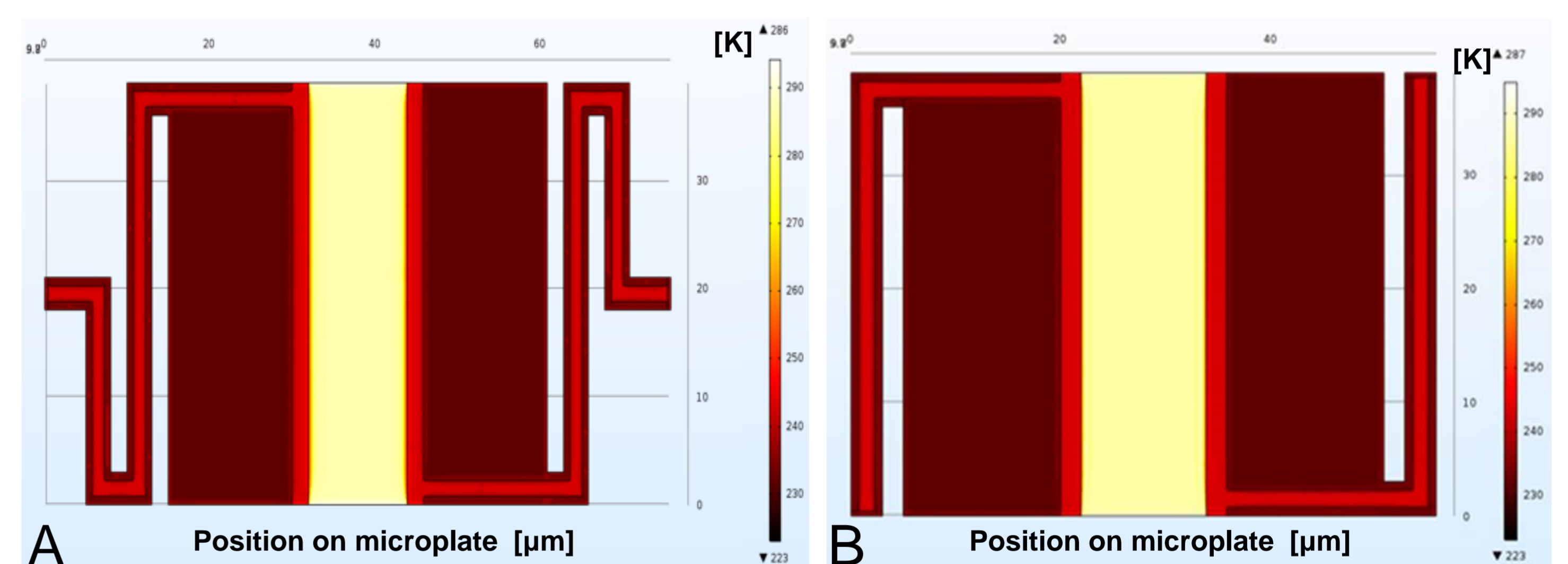

Figure 5 Visual representation of T distribution for: a)Long-arm   and b)Short –arm geometry

Results obtained from modelling in COMSOL Multiphysics® Software, have been checked analytically and have proved that the long-arm geometry has a low thermal conductance and a long time constant, and therefore a higher responsivity.

CONCLUSION

In order to achieve a high pixel responsivity, and thereby enhance the device's performance, the length of the supporting arms should be maximised and the width and thickness should be minimised.