Embedded Microfluidic/Thermoelectric Generation System for Self-Cooling of Electronic Devices

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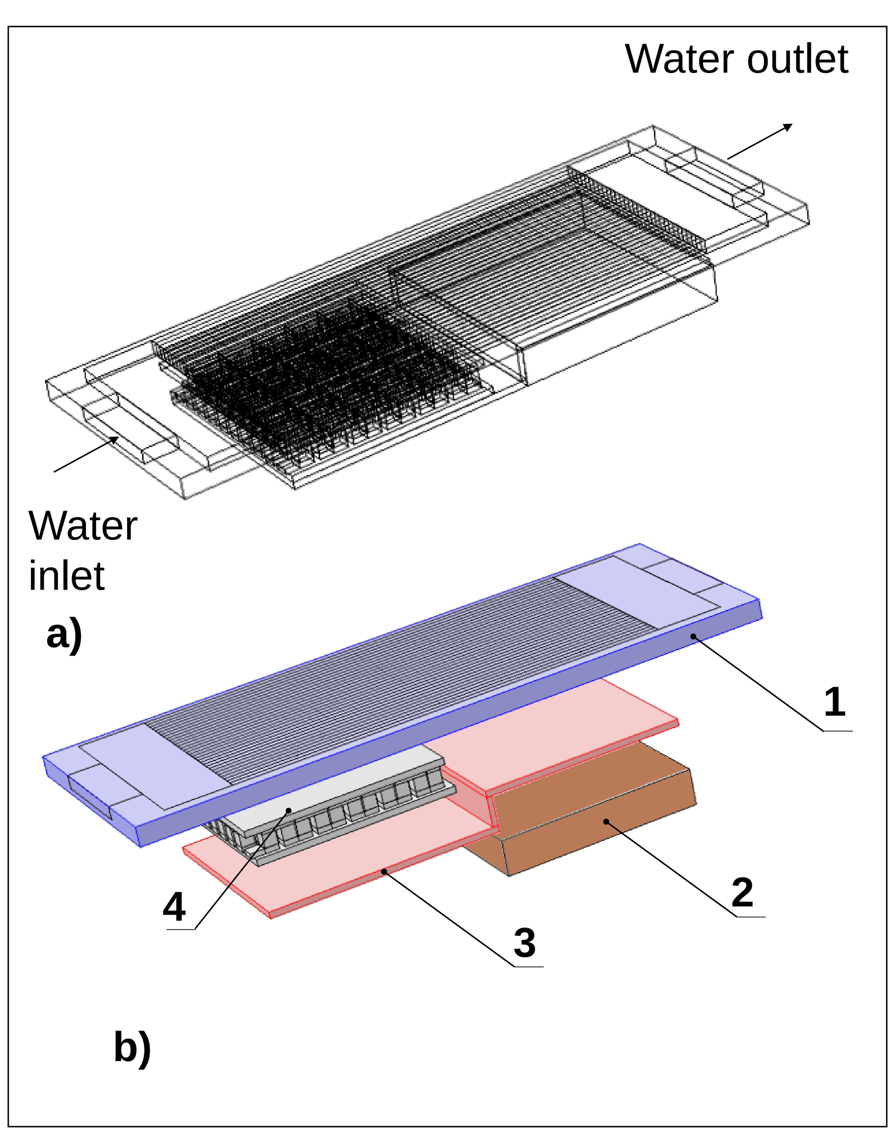
Introduction

In this paper, a 3D electro-conjugate heat transfer model was made to study the an embedded microfluidic/TEG system (μF/TEG) system. The application of μFS for TEG applications has been demonstrated which resulted in compact and effective cooling systems as compared to macro fluid systems.[1,2].
An innovative embedded microfluidic/TEG system (μF/TEG) system is proposed which enables a device to be able to provide power to its cooling system eliminating external power input and resulting in energy efficient and more reliable heat removal system. The research identifies important heat transfer, fluid flow and electrical parameters and optimization to enable the system to generate enough electricity to cool itself.

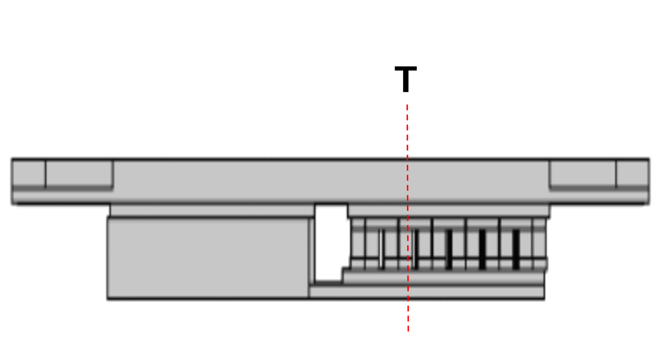
Embedded μF-TEG system

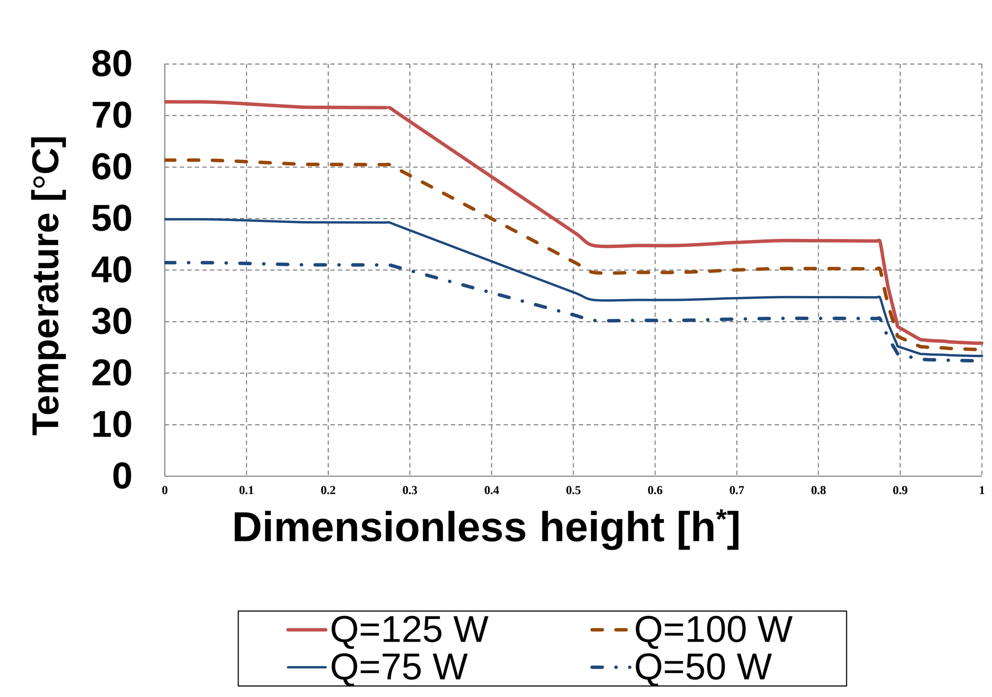


Embedded Microfludic/TEG system a) Wire frame rendering b) assembly diagram. (1-Microfluidic system; 2-Heated aluminum block; 3-Spreader; 4- TEG module)

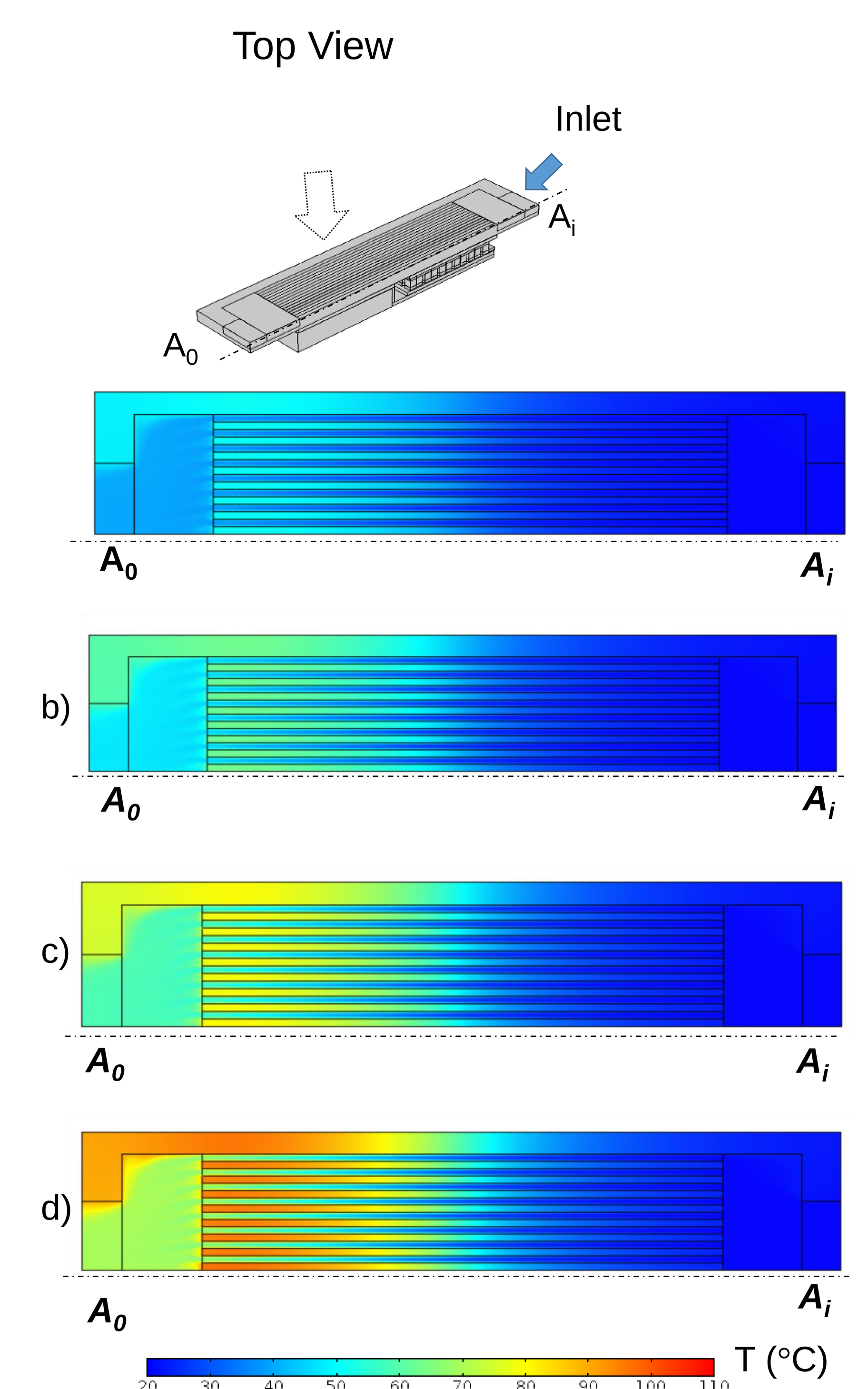
USE of COMSOL Multiphysics

Numerical simulations were conducted using the commercial FEM solver COMSOL (Version 4.4). 3D simulation was implemented on half part of the model using the symmetric condition to reduce computational need.

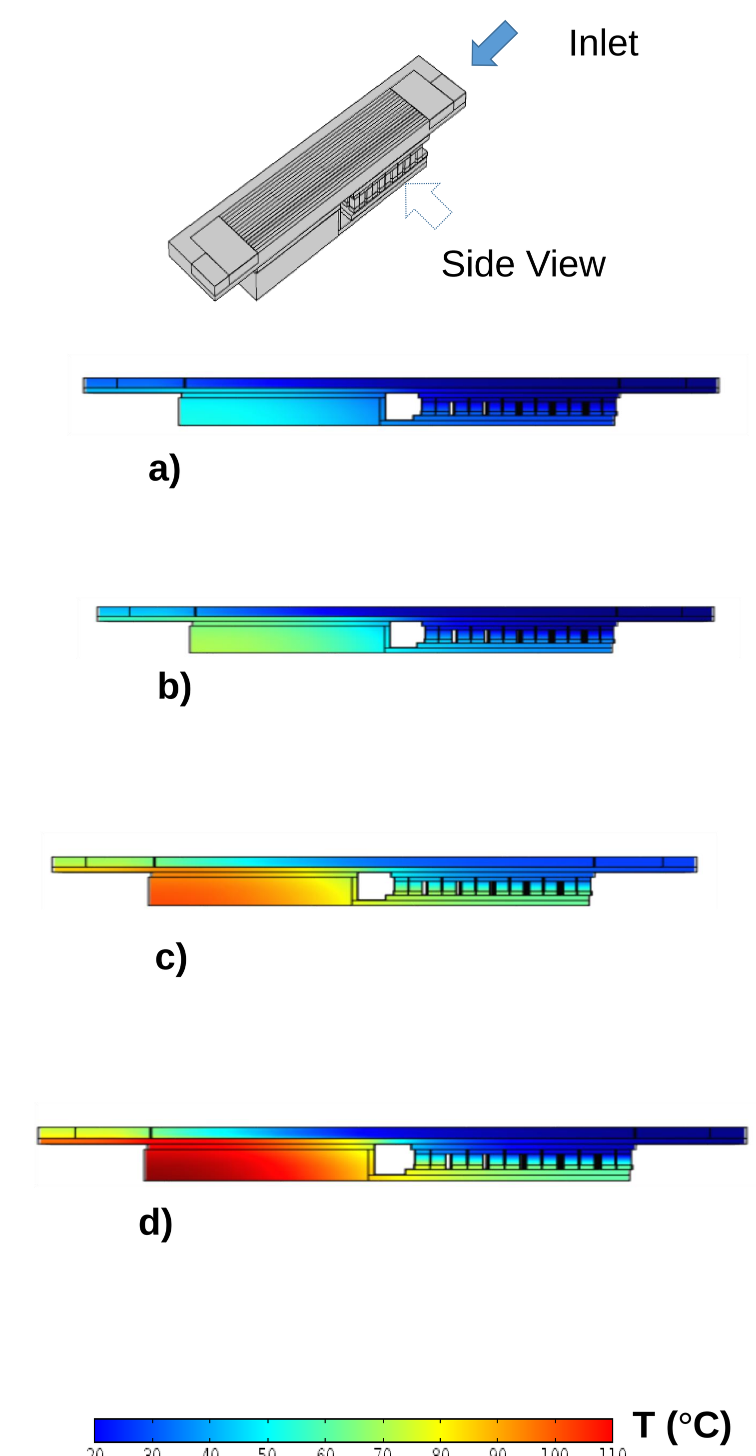




Temperature distribution along line T-T



Temperature distribution (Top View) for heating power input a) 50 W b) 75 W c) 100 W d) 125 W



Temperature distribution (Side View) for heating power input a) 50 W b) 75 W c) 100 W d) 125 W

Results

The TEG module produces more power as the heat input to the heated block increases. The power produced by TEG increased from 2.3 mW to 14 mW corresponding to heating power of 50 W to 125 W respectively. There is a 50% increase in power production for 25 W increases from 50 W to 75 W and 75 W to 100 W of heating power.

Conclusion

An electro-conjugate heat transfer model was made to study the an embedded microfluidic/TEG system (μF/TEG) The system aims to minimize or eliminate external power input enabling a self-cooling by providing self-sustaining cooling power resulting in energy efficient and more reliable heat removal system.. COMSOL was utilized to analyze temperature and electrical characteristics of the embedded microfluidic/TEG system (μF/TEG) system The system has been able to maintain the temperature of the electronic device below 80 °C while producing up to 14 mW of power.

References

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[2] Rezania, A., Yazawa, K., Rosendahl, L. A., and Shakouri, A., Co-optimized design of microchannel heat exchangers and thermoelectric generators, *Int. J. Therm. Sci.*, **72**(0), pp. 73–81(2013).