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Electronic Supplementary Information

High-temperature tolerance of piezoresistive effect in p-4H-SiC for harsh environment sensing

Tuan-Khoa Nguyen,*[1] Hoang-Phuong Phan,[1] Toan Dinh,[1] Abu Riduan Md Foisal,[1] Nam-Trung Nguyen,[1] and Dzung Viet Dao[1,2]

[1] *Queensland Micro- and Nanotechnology Centre, Griffith University, Brisbane, Queensland 4111, Australia*
[2] *School of Engineering and Built Environment, Griffith University, Gold Coast, Queensland 4215, Australia*

Straining analysis

To induce a uniaxial strain to the piezoresistor, a bending method method was utilized which is a doubled-layer cantilever as shown in Figure S1 (a). The analytical model is equivalent to a cantilever with one clamped end, while a static force was applied to the other end. Considering

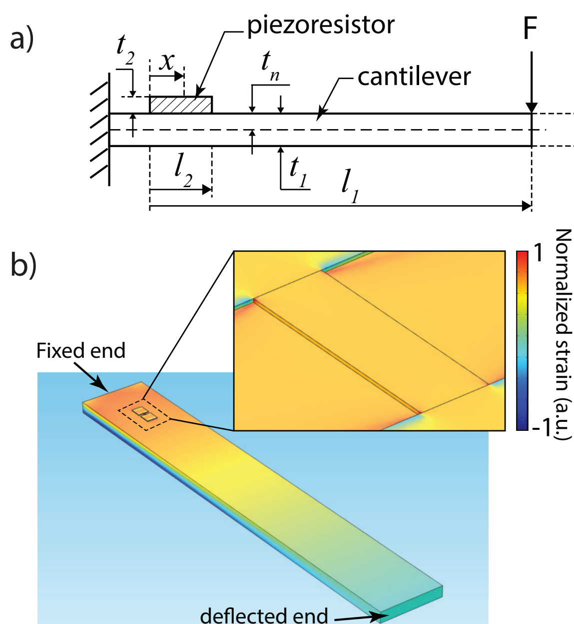

Figure S1: a) Analytical model of the bending beam method consisting of two layers where $t_2 \ll t_1$. b) Finite element analysis (FEA) result of the bending beam configuration indicates a uniformly distributed strain in the p-type piezoresistor lying on the top surface of the 4H-SiC beam.

the mesa structures in the p-type layer lying on the top of a substrate, we can derive the strain function induced on the piezoresistor as [1]

$$\varepsilon(x) = \frac{F}{bD}(l_1 + l_2 - x)t_n \tag{S1}$$

where F is the applied force at the free end, b is the width of the SiC beam, t_n is the length from the neutral plane of the bent beam to the p-type 4H-SiC layer, l_1 and l_2 are the distance from the piezoresistor to the free end and the length of the piezoresistor, respectively; D is the bending modulus which is defined by $D = E(t_1^4 + t_2^4 + 2t_1t_2(2t_1^2 + 2t_2^2 + 3t_1t_2)/(12(t_1 + t_2))$, where t_1 and t_2 are the thicknesses of the substrate and the p-type piezoresistor, respectively; the two layers are made of the same material with the Young's modulus E.

The thin sensing layer lies on top of the thick substrate with a ratio of below 0.003. The boundary condition includes one fixed end and the other deflected end. The finite element analysis, shown in Fig. 1(b), indicates the uniformity of strain transferred from the substrate to the functioning layer lying on the top surface.

References

[1] H.-P. Phan, D. V. Dao, P. Tanner, L. Wang, N.-T. Nguyen, Y.Zhu, and S.Dimitrijev, "Fundamental piezoresistive coefficients of p-type single crystalline 3C-SiC", *Applied Physics Letters*, 104, 111905 (2014).