Graphene-based Wavy Textile Integrated with Ecoflex™ for Tactile Sensor Applications

Rui Chang [1], Abdullah Solayman [1], Rohan B. Ambade [1,2], Yahya Zweiri [1], Yarjan Abdul Samad [1,2,3]

[1]*Advanced Research & Innovation Center, Khalifa University of Science & Technology, Abu Dhabi, UAE*
[2]*Department of Aerospace Engineering, Khalifa University of Science & Technology, Abu Dhabi, UAE*
[3]*Cambridge Graphene Center, University of Cambridge, CB3 0FA, UK*

100063086@ku.ac.ae

Graphene's outstanding electromechanical properties have garnered great interest for tactile sensors, enhancing robotic capabilities [1]. Higher sensitivity is crucial for tactile sensors, requiring deformable materials like rubber [2]. However, rubber-like materials exhibit the Mullins effect, causing undesirable resistance shifts [3]. This study aims to enhance sensitivity through new structural design modifications and mitigate resistance shifts. Wavy structures show significant deformation under applied forces [4, 5]. This work compares coated textile tactile sensors with flat and wavy shapes integrated into Ecoflex™ (Fig. 1a, b). Nonetheless, during cyclic loading tests, both sensors demonstrated resistance shifts over time (Fig. 1c, d), likely attributable to several factors reported in the literature [3, 6, 7]. To address this shift, the difference between initial and minimum resistance for each cycle (ΔR*) was calculated (Fig. 1e, f). Under the same applied stress over 1000 cycles, the difference between the maximum and minimum resistances for a single cycle vary 20.78% for the wavy sensor and 60.07% for the flat sensor (Fig. 1c–f) on average, demonstrating long-term reliability. The wavy sensor exhibits higher sensitivity as it results in considerably higher normalized resistance than the flat sensor (Fig. 1g). Furthermore, under an applied stress of 95 kPa corresponding to a 13% strain, the sensitivity of the wavy textile sensor was 2.25 times higher than that of the flat fabricated textile sensor. This study demonstrates that graphene-coated textile tactile sensors with the wavy structure integrated into Ecoflex™ exhibit higher sensitivity and greater stability under dynamic loading than the flat structure.

References

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Figures

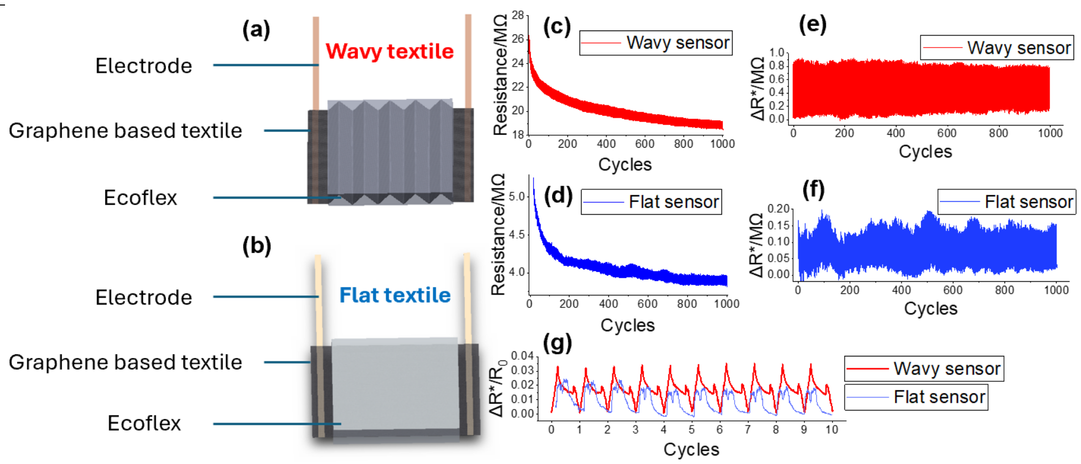

Figure 1: (a, b) Schematic illustration of wavy and flat graphene-coated textile tactile sensors integrated into Ecoflex™, (c, d) Resistance change across 1000 cycles loading test of wavy and flat textile sensors, (e, f) The difference between current resistance and fitted minimum resistance for each cycle (ΔR*) across 1000 cycles loading test of wavy and flat textile sensors, (g) Normalized resistance change ($\Delta R^*/R_0$) across 10 cycles loading test of wavy and flat textile sensor.