UNIVERSITY OF Southampton

Integrating flexible filament circuit for E-yarn

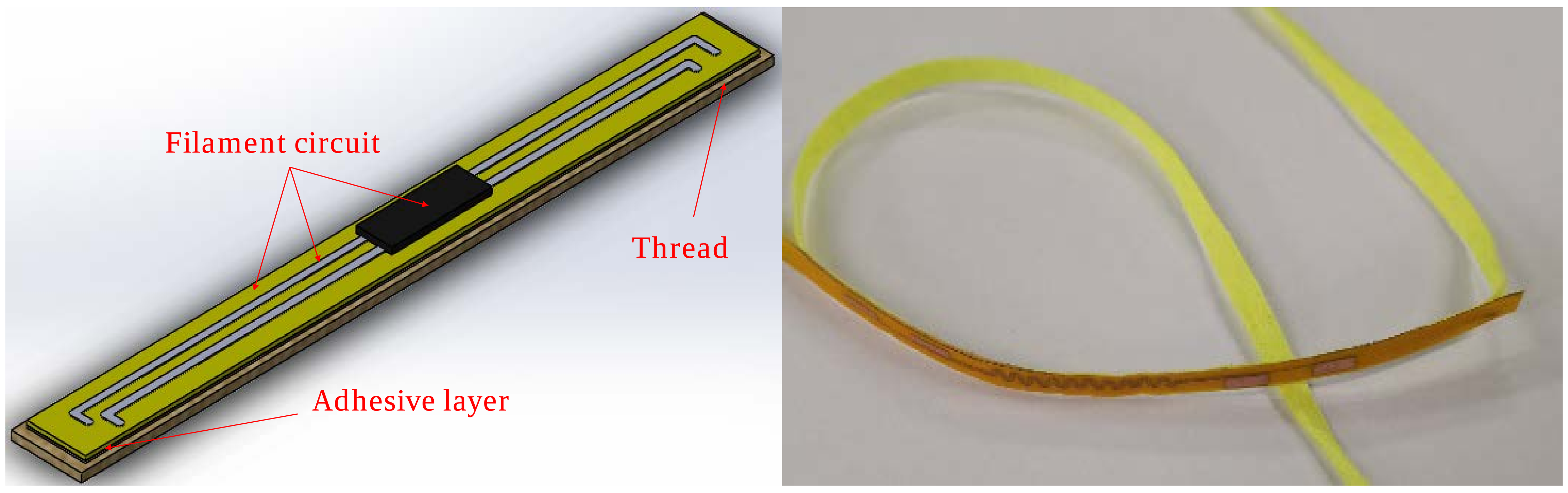
Junjie Shi and Steve Beeby
spb@soton.ac.uk
Centre for Flexible Electronics and E-Textiles, University of Southampton, SO17 1BJ, UK

1 Introduction

Electronic yarns (E-yarns) contain electronics incorporated into the yarn's structure prior to textile or garment production. A major advantage of E-yarns over other e-textiles is that they are imperceptible to the wearer, thus allowing the electronics to be placed comfortably near the skin. Textiles made with E-yarns maintain all normal textile properties such as drapability, flexibility and heat and moisture transfer properties. Here, we propose a method of integrating flexible filament circuits with conventional yarns realizing E-yarns with complex circuits that can potentially be used for large-scale manufacturing. The flexible filament circuit is bonded to the conventional ribbon yarn by a thin layer of flexible adhesive that minimises the impact on the properties of the yarn. A peel test and Peirce's cantilever test of the assembled e-yarn were performed on seven different adhesive composites and three different ribbon yarns to determine the optimum combination for use in subsequent weaving experiments.

2 Fabrication

The flexible filament circuit were prepared by our previous novel functional electronic textiles manufacturing methods with dimensions 100 mm × 2 mm. A thin layer of adhesive was then applied using dispenser printing to the back of the prepared flexible filament circuit to bond the ribbon yarn and form an E-yarn.



(a) (b)

Figure 1. *(a) The* schematic diagram of the structure of E-yarn based on flexible filament circuit and (b) the photo of a fabricated E-yarn

3 Results:

To investigate the feasibility of the integration method, E-yarns were assembled using seven different adhesives and three commercially available ribbon threads. The peel test is performed in accordance with ASTM F88 standard test method at speed of 250 mm/min. The assembled yarn's flexibility was determined by Peirce's test, as shown in Figure 3. The length of overhang l is measured at α=41.5°. The results in Figure 2 and Table 1 show that the Masterbond EP37-3FLF 2-part epoxy adhesive maintains the structural integrity of the E-yarn with a peel strength in excess of 1 N while not increasing the rigidity of the filament circuit.

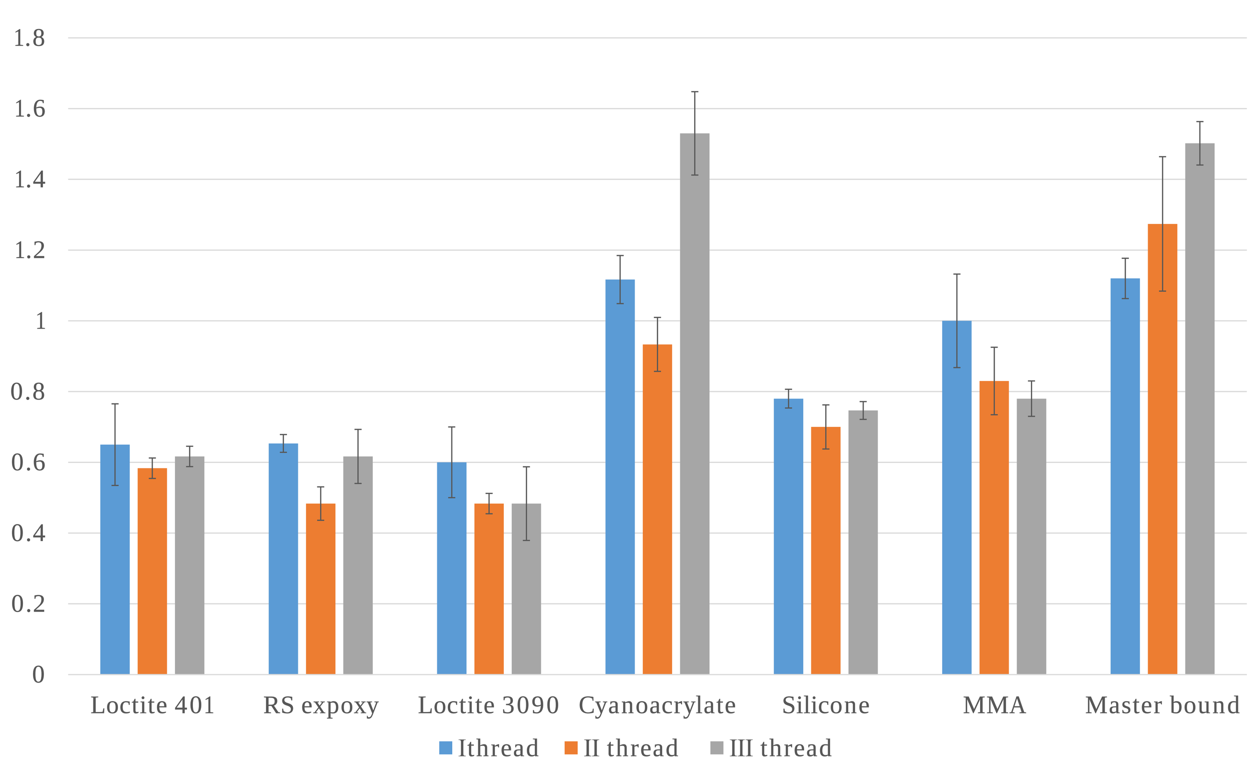


Figure 2. The peel testing results

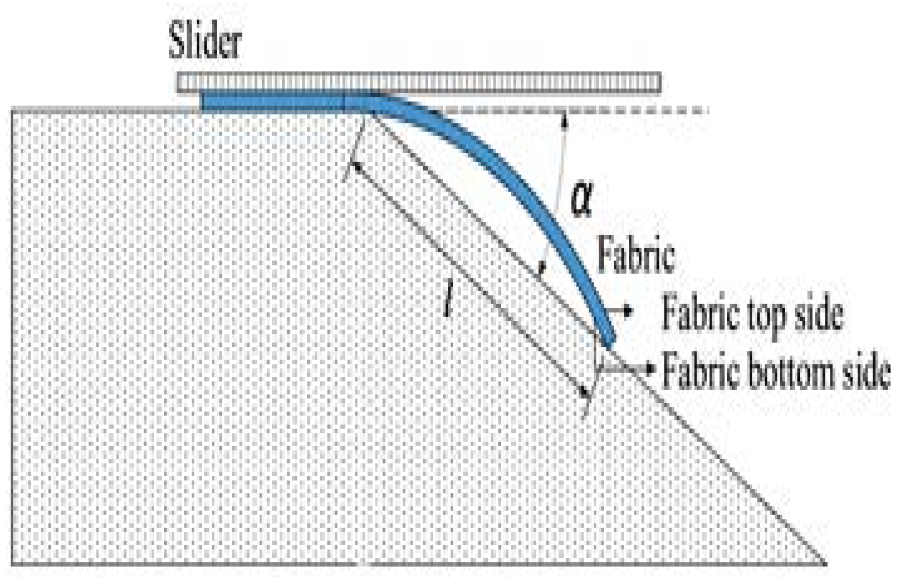


Figure 3. The schematic of the Peirce test for the flexible filament circuit with an adhesive layer at α=41.5°

	Distance
Flexible filament circuit	7.5 cm
Silicone	8.1 cm
MMA	8.2
Masterbond EP37-3FLF	7.8 cm
Loctite 401	>10 cm
Cyanoacrylate	>10 cm
Loctite 3090	>10 cm
RS expoxy	>10 cm

Table 1. The Peirce test result for flexible filament circuit with seven different adhesive

4 Conclusions:

In summary, an integration method of E-yarn based on a flexible filament circuit made through a flexible adhesive layer is proposed. These experimental results show that the Masterbond flexible adhesive layer can achieve a strong bond while not the flexibility of the filament circuit. This makes it possible to apply this integrated approach to the fabrication of E-yarn with complex flexible electronic circuits. Future work will explore compatibility with automated weaving processes.

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