Electronic textiles for personal thermal management

Ashleigh Naysmith[1], Naeem S. Mian[2], Sohel Rana[1]

[1]*Department of Fashion and Textiles, University of Huddersfield;*
[2]*Department of Engineering and Technology, University of Huddersfield*

Ashleigh Naysmith

@ashnaysmith

ashleighnaysmith

e. ashleigh.naysmith@hud.ac.uk

Technical Textiles Research Centre

1. Introduction

• Personal thermal management devices aim to **reduce** societies' dependency on **energy** intensive heating and cooling systems, whilst **increasing** individual **thermal comfort**.

• Electronic textiles (e-textiles) offer increased thermal comfort and user control through functionalisation of commonly-worn textile garments.

• Silver nanoparticles are electrically-efficient and already used in the antimicrobial textile industry.

2. Aims

1. Develop a **multifunctional e-textile based personal thermal management device.**
2. Use a conducting polymer to improve the **adhesion and biocompatibility** of the e-textile.
3. The e-textile is to function with high electrical efficiency using **minimal power requirements**.
4. Optimise the development process by using **design of experiments**.
5. Use **environmentally-benign** methods and nanomaterials.

3. Preparation of polypyrrole –silver nanoparticle- treated linen

• A green synthesis method using **lime peel** extract was used to produce the silver nanoparticles.

• The synthesis parameters were optimised following a **Plackett-Burman method** of experimental design.

• E-textile samples were developed by dip coating linen in silver nanoparticle and then conducting polymer (polypyrrole) solutions.

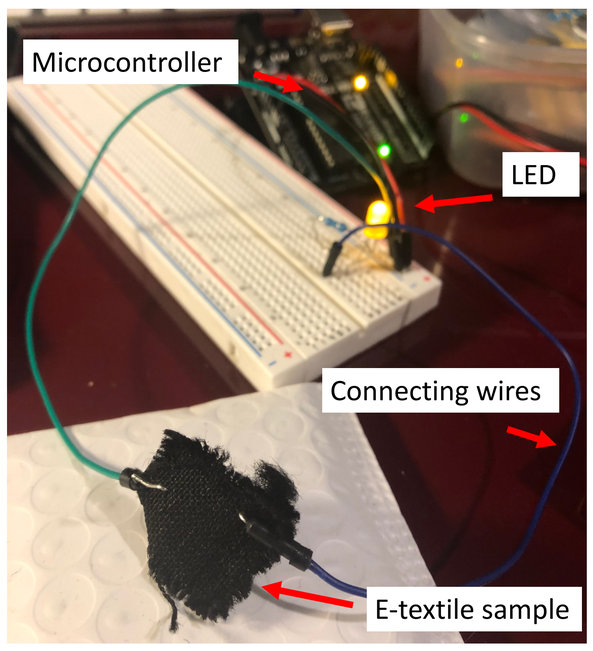

Figure 1: Silver nanocomposite coated linen connected to microcontroller.

4. Results

• The statistical analysis revealed that silver nanoparticle size and quality was affected by the **concentration** of silver nitrate and the reaction temperature.

• The heating performance of the e-textile reaches **120°C** temperature output with 10V applied voltage (Fig. 2(a)).

• The e-textile demonstrates **temperature sensing and strain sensing** properties (Fig. 2 (b-d)).

• The initial development exhibits **unsatisfactory adhesion of the coating to the fabric. The coating is wearing off too quickly.** However, this may be due to an excess of the composite coating which will stabilise after initial wash tests[1-3].

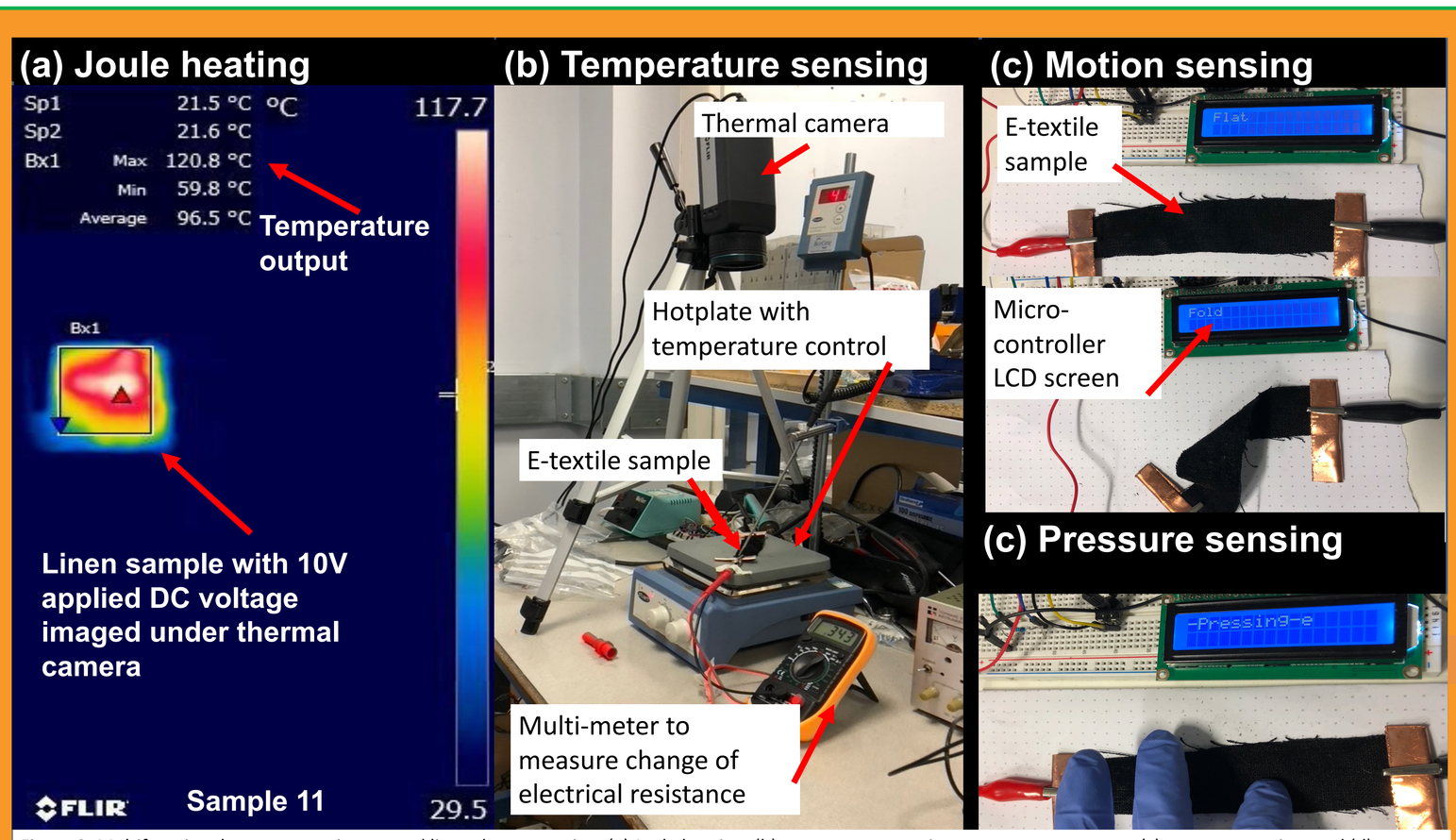

Figure 2: Multifunctional nanocomposite-treated linen demonstrating: (a) Joule heating; (b) temperature sensing measurement set up; (c) pressure sensing; and (d) pressure sensing functionality

5. Conclusions and Future Work

1. A silver nanoparticle and polymer treated linen e-textile has been developed demonstrating multifunctional sensing properties, including **heating of up to 120°C**.
2. The **concentration** of starting materials has the most significant impact on the size and quality of the silver nanoparticles.
3. **Further work** is underway to analyse the size and shape of the silver nanoparticles, and the sensing, durability and comfort properties of the developed e-textile.

6. References

1. R. Islam, N. Khair, D. M. Ahmed and H. Shahariar, *Materials Today Communications*, 2018, **19**, 32--38.
2. A. Lund, S. Darabi, S. Hultmark, J. D. Ryan, B. Andersson, A. Ström and C. Müller, *Advanced Materials Technologies*, 2018, **3**, 1800251.
3. L. Sun, F. Wang, J. Jiang, H. Liu, B. Du, M. Li, Y. Liu and M. Li, *Cellulose*, 2020, **27**, 8923--8935.

7. Acknowledgements

This work was supported by the UK Engineering and Physical Sciences Research Council (EPSRC) grant EP/T51813X/1 for the University of Huddersfield Doctoral Training Programme