

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/338751428>

A broadband outlook on flexible and textile RF energy harvesting and wireless power transfer: from near-field to 5G

Conference Paper · January 2020

CITATIONS

0

READS

23

5 authors, including:



Mahmoud Wagih

University of Southampton

21 PUBLICATIONS 33 CITATIONS

SEE PROFILE



Abiodun Komolafe

University of Southampton

30 PUBLICATIONS 97 CITATIONS

SEE PROFILE



Bahareh Zaghari

University of Southampton

34 PUBLICATIONS 72 CITATIONS

SEE PROFILE



Alex S Weddell

University of Southampton

73 PUBLICATIONS 909 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



EnABLES (Free access to facilities and expertise) [View project](#)



I2BS project [View project](#)

A Broadband Outlook on Flexible and Textile RF Energy Harvesting and Wireless Power Transfer: from Near-Field to 5G

Mahmoud Wagih, Abiodun Komolafe, Bahareh Zaghari, Alex S. Weddell, Steve Beeby

School of Electronics and Computer Science, University of Southampton, SO17 1BJ, U.K.

Wireless power transfer (WPT) and Radio Frequency (RF) energy harvesting (EH) are increasingly seen as an enabling technology for power-autonomous Internet of Things (IoT) [1, 2]. RFEH and WPT are a particularly attractive power source for flexible, printed, and e-textile systems due to their compatibility with standard fabrication processes, abolishing the need for specific materials and transducers. This work provides an overview on flexible WPT at multiple frequencies (6.78 MHz to 26 GHz) and techniques from near-field WPT to Millimetre-wave WPT and RFEH. Figure 1 shows our developed flexible and textile WPT and RFEH coils and antennas.

Near-field power transfer has been utilized for high-efficiency charging of consumer electronics as well as RFID. The coil shown in Figure 1-a has been fabricated using embroidered fabric Litz wires and utilized in two modes of operation at 6.78 MHz: resonant inductive coupling and radiative near-field WPT. The coupled WPT achieves the highest reported efficiency of 82% in human proximity [1]. The radiative approach achieves unmatched separation-independence, in a 27 m³ volume, but is limited to μ W power levels due to the FCC's regulations.

Ambient RF sources, such as cellular networks, possess similar energy densities to ambient energy sources such as human vibrations. A broadband antenna, Figure 1-b, has been developed to recycle the energy from cellular networks, independent of polarization, with bandwidth covering the whole UHF cellular and license-free spectrum. The antenna has been matched to a flexible low-cost rectifier using lumped inductive matching, creating the first triple-band fully-textile rectenna, achieving up to 40.3% RF-DC efficiency at -20 dBm (10 μ W). An alternative packaging approach has been proposed: a coplanar-waveguide (CPW) rectenna yarn (Figure 1-c) has been presented for fully-concealed textile RFEH at 915/868 MHz, improving reliability and integration in textile weaves.

With the anticipated growth of the wireless-powered IoT market traffic-related issues may arise, and the "recycling" of ambient energy could overload existing networks. Millimetre-wave (mmWave) WPT, as part of future 5G networks, presents a potential solution to the traffic issues and promises improved energy coverage compared to sub-6 GHz bands [2]. As the main challenge in mmWave antennas and circuits are the high-cost of the RF-substrates and fabrication processes, the proposed antenna in Figure 1-d has been presented to overcome the efficiency barrier and present the first textile mmWave antenna for 5G WPT/RFEH, achieving up to 77% radiation efficiency at 26 GHz [2]. A fully-distributed rectifier has been designed and fabricated to achieve a 1V DC output at 24 GHz from less than 10 dBm of mmWave power.

References

- [1] M Wagih et al. *Dual Receiver Wearable 6.78 MHz Resonant Inductive Wireless Power Transfer Glove using Embroidered Textile Coils*. *IEEE Access*, 2019
- [2] M Wagih et al. *Millimeter-Wave Textile Antenna for On-Body RF Energy Harvesting in Future 5G Networks*. *IEEE Wireless Power Transfer Conference*, 2019, London, U.K.

Acknowledgement - The authors would like to thank the European Commission for supporting this work under H2020-EU.1.4.1.2 and the UK EPSRC for supporting this work under Grant EP/P010164/1

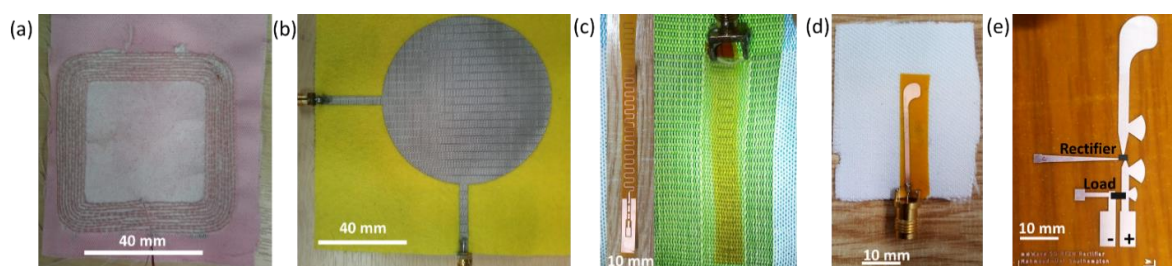


Figure 1. Developed WPT and RFEH flexible and textile antennas and harvesters: (a) 6.78 MHz WPT coil, (b) Broadband (0.7-3 GHz) dual-polarization ambient RFEH fully-textile antenna, (c) 868 MHz CPW voltage doubler concealed rectenna yarn, (d) 5G mmWave textile antenna (e) Flexible mmWave broadband voltage doubler.