

Smart tags and antennas all made of carbon

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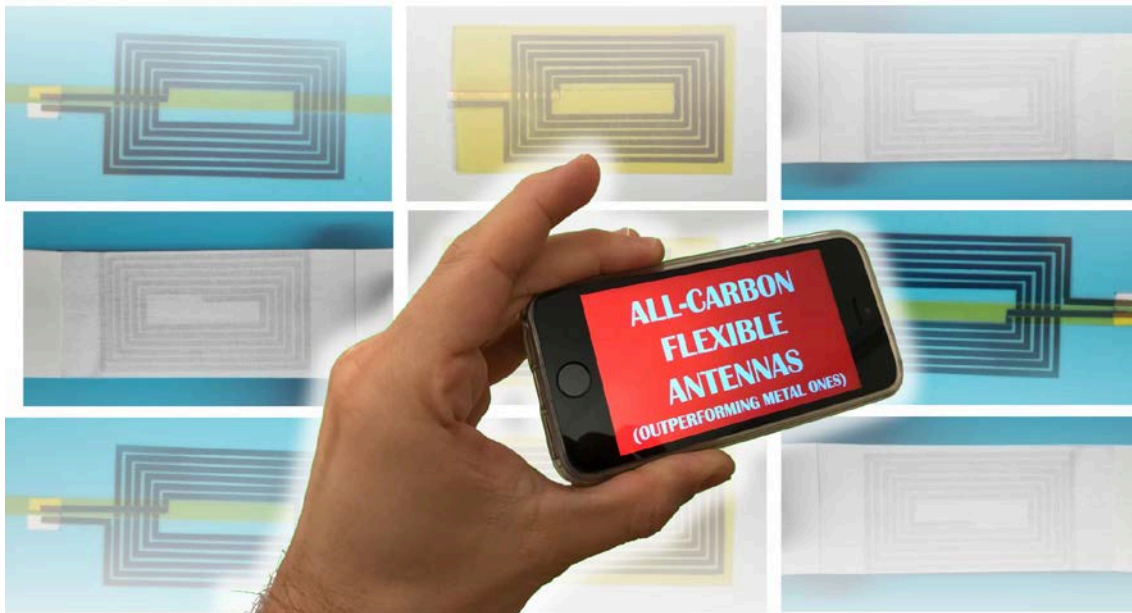


Fig. 1: Images of graphene-based flexible antennas embedded in various polymer or substrates, and a typical smartphone used to communicate with them.

What is it? A key target for modern technology is to replace metals with lighter, cheaper, less energy-consuming and better recyclable materials. We successfully produced graphene-based flexible antennas, where the metal has been completely replaced by highly conductive carbon. The antennas could exchange information with near-field communication (NFC) devices such as a mobile phone, matching the performance of conventional metallic antennas. The antennas are chemically inert, highly resistant to thousands of bending cycles and can be deposited on different standard polymeric substrates or silk tissues. Fully working graphene smart cards were prepared in order to be used as electronic keys, business cards and others typical NFC applications. The procedure has been patented and published in a joint paper with the companies Emberion, Beko, Graphitene and STMicroelectronics.

Why does it matter? Near-field communication (NFC) antennas are a ubiquitous method for two electronic devices to transfer data to each other. Anytime you need a way to communicate a small amount of data over a relatively short distance wirelessly, a NFC antenna is probably involved. They are used in security cards, tracking of inventory and payment systems. The most distinctive characteristic of NFC is the fact that it can transmit small amount of data wireless only within a close range while other methods, such as Bluetooth and Wi-Fi, have a wide transmit range of up to 10 or even 100m. The reason why NFC technology is used to identify objects is that, with such a close transmitting range, it is more secure and less vulnerable to data hijacking. Application areas are tracking and managing inventories, assets, people, animals, contactless payment systems, and security cards.

How does it work? This material features a high value of conductivity ($>10^5$ S/m) comparable to monocrystalline graphite, but is much more flexible and processable. We first studied the replacement of metal with carbon antennas using computer modeling, to select the best design. Then we manufactured several devices to be used according to the communication protocol ISO/IEC 15693. The inductance of the G-paper antennas was tested before and after hundreds of thousands of bending cycles at bending radii of 45 and 90 mm. During bending the self-resonance frequency and inductance peak showed minimal variation and the resistance at 1 MHz was stable outperforming standard, commercial metallic antennas.

Publication A. Scida, S. Haque, E. Treossi, A. Robinson, S. Smerzi, S. Ravesi, S. Borini, and V. Palermo, *Application of graphene-based flexible antennas in consumer electronic devices*. **Materials Today**, 21, (2018) 223.

Patent *Device of the type of an antenna, a heater, an electromagnetic screen and the like, process for providing devices of the type of an antenna, a heater, an electromagnetic screen, an electrical interconnection and the like, a substantially laminar blank for providing devices of the type of an antenna, a heater, an electromagnetic screen, an electrical interconnection, a circuit and the like*. WIPO (PCT) Patent, WO2017081195A1, (2018)

Media coverage

Highlight on Materials today <https://www.materialstoday.com/carbon/news/graphene-unlocks-wearable-smart-electronic-devices/>

Graphene Enables Fully Flexible NFC Antennas <https://graphene-flagship.eu/graphene-enables-fully-flexible-nfc-antennas>

Science Daily <https://www.sciencedaily.com/releases/2016/11/161129084229.htm>

Electronics 360 <https://electronics360.globalspec.com/article/7796/flexible-graphene-based-nfc-antenna-developed>

NFC World <https://www.nfcworld.com/2016/12/05/348851/graphene-nfc-antennas-pave-way-cheaper-stronger-connected-wearables/>

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All about circuits <https://www.allaboutcircuits.com/news/everything-you-need-to-know-about-the-future-of-graphene/>

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