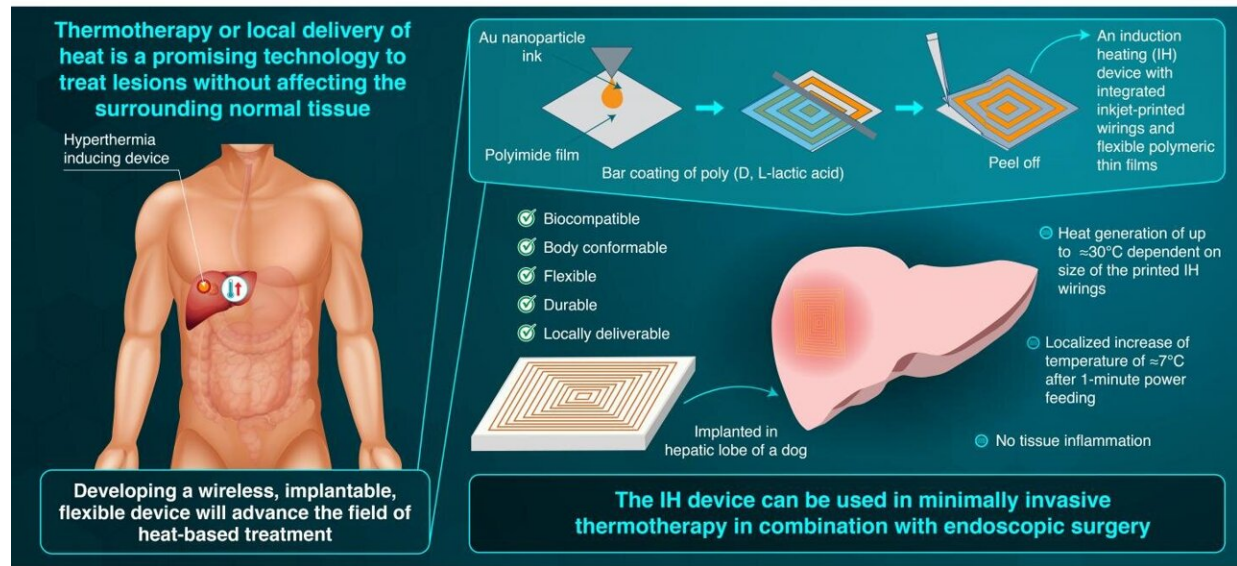


Turning the heat on: A flexible device for localized heat treatment of living tissues

June 9 2021

Induction Heating-based Flexible Device to Revolutionize Targeted Thermotherapy



Thermotherapy or local delivery of heat is a promising technology to treat lesions without affecting the surrounding normal tissue

Hyperthermia inducing device

Developing a wireless, implantable, flexible device will advance the field of heat-based treatment

Biocompatible
Body conformable
Flexible
Durable
Locally deliverable


Au nanoparticle ink
 Polyimide film
 Bar coating of poly (D, L-lactic acid)
 Peel off
 An induction heating (IH) device with integrated inkjet-printed wirings and flexible polymeric thin films

Heat generation of up to $\approx 30^{\circ}\text{C}$ dependent on size of the printed IH wirings
 Localized increase of temperature of $\approx 7^{\circ}\text{C}$ after 1-minute power feeding
 No tissue inflammation

Implanted in hepatic lobe of a dog

The IH device can be used in minimally invasive thermotherapy in combination with endoscopic surgery

Flexible induction heater based on the polymeric thin film for local thermotherapy
 Saito et al. (2021) | 10.1002/adfm.202102444
 Advanced Functional Materials

 東京工業大学
 Tokyo Institute of Technology

Induction Heating-based Flexible Device to Revolutionize Targeted Thermotherapy. Credit: Tokyo Tech

Thermotherapy or heat treatment can help in treating lesions and other tissue injuries. For example, chemotherapy or radiotherapy, when combined with thermotherapy, kills tumorous cells more effectively. Thermotherapy is considered a promising approach for treating internal lesions, but the advancement in the field depends on the availability of

patient-friendly heat-inducing devices capable of rapidly increasing the temperature of target tissues.

Current clinical practices around thermotherapy majorly employ heat-generating devices that are probed inside the [human body](#) or are in contact with the skin. Receiving energy from external power sources and often operating through converging magnetic fields, these devices are usually large in size and static, limiting the movement of patients and also prolonging operational time.

An alternative option is small and [flexible devices](#) that can be implanted in the patient's body; however, such implantable devices must be flexible, body-compatible, heat resistant, and be powered wirelessly for heat generation—some of the criteria that are essential for their [clinical use](#).

Recently, researchers at Tokyo Tech have innovated a heat-generating [device](#) that can revolutionize the field of thermotherapy by meeting all of the above criteria. Their innovation was reported in an article published in *Advanced Functional Materials*. Discussing their motivation, Associate Professor Toshinori Fujie, who led the study, explains, "One of the major obstacles in developing an implantable heating device is the requirement of incorporating [electronic elements](#) such capacitors in the circuit of the device itself. Such insertion takes away the flexibility required for internal implantation. To overcome this, we took the help of induction-heating, the same technology that is used in cooking heaters." The working of such a device is based on the premise that the [magnetic field](#) generated by a coil with a high-frequency current induces current flow in a closely placed metal. Owing to its internal resistance, the metal then heats up automatically.

Developing such an induction heating device required ingenious design. First, the researchers printed the electronic wiring on a polyimide film

with an 'ink' made of gold-nanoparticles. Next, a layer of poly (D, L-lactic acid) or PDLLA was coated above the printed film. In addition to heat-durability, the PDLLA layer is biodegradable and biocompatible, making it an excellent candidate for the base material of the device. Then, using tweezers, the researchers peeled off the PDLLA layer, causing it to come off the polyimide film. The result was a flexible device, conformably attaching to human skin, with electronic wirings printed on it.

Once the device showed satisfactory electrical performance, [mechanical strength](#), and heat generation capacity, the researchers assessed its clinical functionality by planting it on living tissue—the hepatic lobe of a beagle dog. The results were extremely promising. When a transmitter coil was placed directly on the device for one minute, the temperature of the liver tissue increased up to 7°C without any indication of tissue burning.

Assoc. Prof. Fujie highlights the feat of their research "The flexibility, biocompatibility, and wireless-powered heating capacity of our device opens up the possibility of using thermotherapy in wide clinical scenarios including minimally invasive endoscopic surgery. Moreover, by adjusting the number and size of these devices, lesions of different sizes can be treated."

More information: Masato Saito et al, Flexible Induction Heater Based on the Polymeric Thin Film for Local Thermotherapy, *Advanced Functional Materials* (2021). [DOI: 10.1002/adfm.202102444](https://doi.org/10.1002/adfm.202102444)

Provided by Tokyo Institute of Technology

Citation: Turning the heat on: A flexible device for localized heat treatment of living tissues

(2021, June 9) retrieved 20 November 2023 from

<https://medicalxpress.com/news/2021-06-flexible-device-localized-treatment-tissues.html>

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