Compact Self-powered Actuator for Accurate Drug Delivery
Technology #10494-12297-14440

Applications

- Self-powered, self-administrable electrochemical infusion pumps for drug delivery, such as insulin delivery for diabetes management
- Electrically operated unfolding structures, such as stents, scaffolds, medical implants, or surgical tools

Problem Addressed

Biologics can't be taken orally and are often administered via long hours of intravenous (IV) infusions in a dilute form or via painful hypodermic injections in a viscous, concentrated form. Because of these delivery challenges, patients often fall out of compliance with their treatment regime. Pen injectors and patch pumps for self-administering biologics have been invented to address these challenges; however, these devices are impractical and bulky when required to administer a dosage volume larger than 2 cc.

Taking a radically different approach to solve these problems, the inventors adapted an electrochemical actuator, originally invented for large-scale morphing structures, to create a small, accurate, repeatable, external infusion pump that can painlessly deliver a dose up to 20 cc of high viscosity drugs. Previously known non-faradaic methods of electrochemical actuation with gaseous or liquid phase actuation materials provide low elastic moduli and consequently low actuation energy density and actuation stress. The electrochemical actuator presented in this invention is capable of providing high actuation energy density, high actuation authority (stress), large free strain, and useful bandwidth.

Technology

Spun out of DoD funded research, this invention presents a self-powered, external patch-style infusion pump with a built-in electrochemical actuator that can not only provide the force needed to subcutaneously inject medicines but would also ensure a constant rate of administration over time.

Actuation generally refers to a mechanism by which an object, or portion of an object, can be adjusted or moved by converting various types of energies, such as electric or chemical energy, into mechanical energy. While it has been known that many solid intercalation compounds used in batteries undergo significant volume changes during ion exchange, the accompanying mechanical energy has not previously been exploited for practical purpose. The inventors harnessed this dynamic battery deformation to power morphing activity, originally for large-scale morphing structures, such as airplane wings, to improve performance and energy efficiency of aircrafts. This morphing concept was further adapted for its use in a medical device: self-powered electrochemical infusion pumps with lithium battery as a high energy density actuator.

The pump is an electrochemical cell that is fabricated in the charged state and expands upon discharging. The pumping rate is determined by the cell expansion rate, which is in turn controlled simply by controlling the discharge rate of the cell by varying the resistance of the external circuit.
through which the cell discharges. The result is an extremely precise, repeatable, and linear actuator pump that can painlessly deliver high viscosity drugs with high accuracy and repeatability. This external infusion pump can be custom-tailored to treat specific illnesses using specific medicines. Because the battery is the actuator, no separate power source is needed: the device is self-powered.

Note: There are several issued foreign patents (available on request).

**Advantages**

- Self-powered drug delivery device; the lithium battery serves as the actuator and the power source
- Wireless control of drug dispense rate; self-powered electrochemical pump can be controlled and monitored wirelessly
- Accurate, repeatable, low pain delivery of high viscosity drugs
- Self-administrable device; better patient compliance, fewer hospitalization, and lower health care costs
- The electrochemical actuator presented in this invention can be used singly or in combination in a broad range of adaptive structures
- There exist a large number of active materials that can be used for mechanical actuation; properties that guide the selection of specific materials include the desired expansion, cost, rate capability, and density

**Categories For This Invention:**

- Life Sciences
- Biotechnology
- Other (Biotechnology)
- Clinical Applications
- Other (Clinical Applications)
- Medical Devices
- Therapeutic (Medical Devices)
- Therapeutics
- Drug Delivery

**Intellectual Property:**

- Electrochemical actuator
  - Issued US Patent
  - 7,872,396
- Electromechanical actuator
  - Issued US Patent
  - 7,999,435
- Electrochemical actuator
  - Issued US Patent
  - 8,093,781
- Electrochemical actuator
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