Electronically controlled "smart" drugs could minimize side effects

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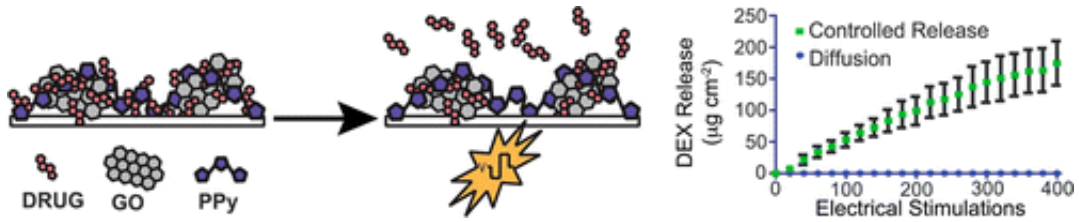

Potential side effects of many of today's therapeutic drugs can be downright frightening—just listen carefully to a drug commercial on TV. These effects often occur when a drug is active throughout the body, not just where and when it is needed. But scientists are reporting progress on a new tailored approach to deliver medicine in a much more targeted way. The study on these new electronically controlled drugs appears in the journal *ACS Nano*.

Xinyan Tracy Cui and colleagues note that in the lab, "smart" medical implants can now release drugs on demand when exposed to various cues, including ultraviolet light and electrical current. These advances are largely thanks to developments in nanomaterials that can be designed to carry drugs and then release them at specific times and dosages. Researchers have also experimented with loading anti-cancer drugs on thin, tiny sheets of graphene oxide (GO), which have a lot of traits that are useful in drug delivery. But current techniques still require tweaking

before they'll be ready for prime time. Cui's team wanted to work out some of the final kinks.

They incorporated GO nanosheets into a polymer thin film that can conduct electricity, loaded it with an anti-inflammatory drug and coated an electrode with it. When they zapped the material with an electric current, they showed that it released the drug consistently in response. They could do this several hundred times. Also, by experimenting with the sizes and thicknesses of the GO sheets, the scientists could change how much drug the nanosheets could carry. Cui said this approach could be useful in treating epilepsy, for example. In that case, medication already lying in wait inside the body could be released at the onset of a seizure.

More information: "Electrically Controlled Drug Delivery from Graphene Oxide Nanocomposite Films" *ACS Nano*, Article ASAP. DOI: 10.1021/nn406223e

Abstract
On-demand, local delivery of drug molecules to target tissues provides a means for effective drug dosing while reducing the adverse effects of systemic drug delivery. This work explores an electrically controlled drug delivery nanocomposite composed of graphene oxide (GO) deposited inside a conducting polymer scaffold. The nanocomposite is loaded with an anti-inflammatory molecule, dexamethasone, and exhibits favorable electrical properties. In response to voltage stimulation, the nanocomposite releases drug with a linear release profile and a dosage that can be adjusted by altering the magnitude of stimulation. No drug passively diffuses from the composite in the absence of stimulation. In vitro cell culture experiments demonstrate that the released drug retains its bioactivity and that no toxic byproducts leach from the film during electrical stimulation. Decreasing the size and thickness of the GO nanosheets, by means of ultrasonication treatment prior to deposition

into the nanocomposite, alters the film morphology, drug load, and release profile, creating an opportunity to fine-tune the properties of the drug delivery system to meet a variety of therapeutic needs. The high level of temporal control and dosage flexibility provided by the electrically controlled GO nanocomposite drug delivery platform make it an exciting candidate for on-demand drug delivery.

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