



## Ultrathin and Flexible Zinc Batteries to Power Tomorrow's Electronics

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driving demand for thin, flexible,

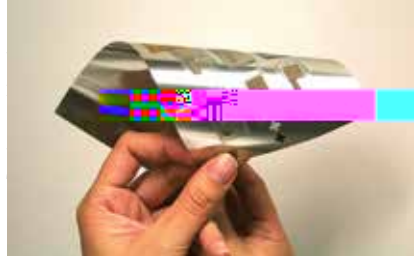
toxicity and green chemistries.

Batteries typically occupy the large

properties. Product designers have tried to push batteries toward thinner form factors (<1 mm), but commercially available battery chemistries have severe performance and safety limitations. For example, lithium-based chemistries require substantial

material to change.

With support from the National Science Foundation, Imprint Energy, Inc., a spinout of the Univ. of California, Berkeley, is commercializing a zinc-based printed, flexible battery (ZincPoly). The innovative feature of this new battery is its highly conductive solid electrolyte, which is composed of air-stable, low-toxicity, earth-abundant non-lithium materials. This electrolyte is an ionic liquid swelled into a polymer to form a gel. The polymer electrolyte exhibits solid-like mechanical strength



ments; and, zinc batteries have high theoretical energy and power densities. Imprint Energy's ultrathin batteries (shown here printed on foil) are high volume energy and low cost, batteries with low materials and manufacturing costs, inherent safety, reliability and form factor flexibility that exceed those of any other commercial batteries with a thickness that grows from the zinc electrode after each use. Image courtesy of Imprint Energy.

electrode shape change due to unstable electrode-electrolyte interactions.

Unlike most traditional zinc alkaline batteries, ZincPoly can be stably recharged. Because of the gel-like structure of the ZincPoly electrolyte,

across the electrolyte, ultimately allowing this chemistry to be sustainably rechargeable.

Imprint Energy's nonaqueous polymer electrolyte maintains high

strength — enabling the necessary physical separation between the two electrodes, says Christine Ho, CTO at Imprint Energy. “Good interfacial

electrolyte is maintained, so the battery is stable when flexed or bent.”

All layers within a ZincPoly battery start as inks that are patterned using common screen-printing equipment. Imprint has printed batteries of different shapes and sizes on various substrates, including foils, plastics, and fabrics. These batteries have been dynamically flexed over a few thousand cycles with good capacity retention. They have undergone testing in several bend configurations and multi-axis dynamic bending, and they are stable when curved to various bend radii and even when creased. The ability to be safely coiled or even punctured greatly expands the potential application opportunities, and gives product designers unprecedented freedom to rethink battery shapes, form factors, and applications in portable electronics.

Imprint Energy is currently producing several hundred batteries a day for research and development purposes, and is developing the ZincPoly technology to satisfy the battery requirements of small portable

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