

LCR Hallcrest Adapts Thermochromic Expertise to Printed Battery Testers

By David Savastano

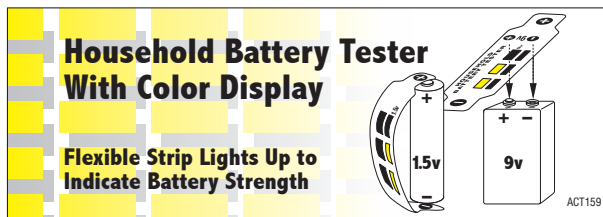
Virtually everyone has had a need for battery testers at some point. After all, it is extremely helpful to know if the battery in your flashlight or game controller is about to run out.

In the 1980s, the major battery manufacturers such as Energizer and Duracell had created battery testers on the side of their batteries, but this is no longer the case.

LCR Hallcrest, a specialist in thermographics, or temperature sensitive, color changing graphic technology, is making strong headway in the field of battery testing, utilizing printed electronics to produce its testers.

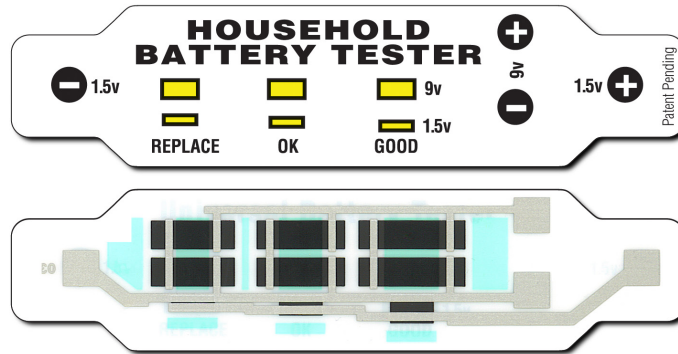
The First Household Battery Tester, LCR Hallcrest's newest development, uses thermochromic leuco dyes in the capacity testing of batteries. The lightweight flexible plastic electrical circuit is printed with conductive ink that measures battery capacity; it is integrated with a thermochromic display that "lights up" to indicate battery power, which is displayed as a color change once the battery terminals are contacted by the strip.

The First Household Battery Tester is designed to test the most prevalent 1.5V and



9V batteries frequently used and commonly found in the home. It will provide years of service, and can be stored in a drawer or toolbox. It is currently marketed through Thermographics as a promotional item and available for immediate purchase at www.thermometersite.com.

As a pioneer with 40 years of experience in thermochromics, LCR Hallcrest is a logical choice for developing this technology, as the company was involved in producing of the earlier battery testers. In addition, LCR Hallcrest designs and produces the Feverscan Forehead thermometers, which are used to monitor a patient's temperature during surgery and in the immediate recovery period. Feverscan Forehead thermometers are currently used in millions of surgeries annually.

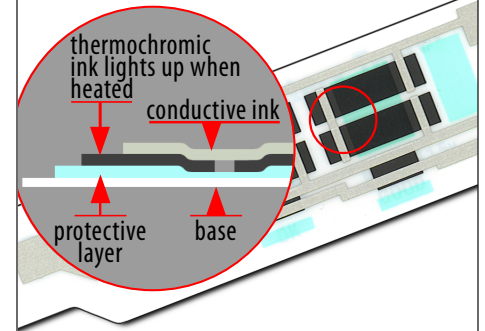


LCR Hallcrest is also known for its Thermax irreversible labels, which trigger at a pre-set temperature, creating a permanent record within the supply chain that temperature has been exceeded. LCR Hallcrest's Thermo-chromic color changing graphic materials are used in consumer products to communicate proper usage or storage conditions. Meanwhile, LCR Hallcrest's Thermographics

division markets cutting edge promotional and premium items that use thermal color change interactively to engage their audience and increase message awareness.

"The Hallcrest name is synonymous with this effort, and has been at the forefront of the innovation, development and manufacturing of trend-setting products such as whimsical novelties like the mood ring of the 1970s, consumer products such as the battery tester, to medical diagnostic thermometers currently used in millions of surgeries annually," said John Romano, director of sales and marketing at LCR Hallcrest.

Printed, layered, conductive and thermochromic ink



The key to LCR Hallcrest's technology is its liquid crystals, which can be accurately set to show color at temperatures $\pm 1^\circ\text{F}$, and leuco dye inks and pigments that can be formulated to turn from color to clear either reversibly or irreversibly. Each technology offers unique capability but together the entire color spectrum is covered within a temperature range of -22°F (30°C) to 554°F (290°C).

The First Household Battery Tester is an ideal opportunity to combine thermochromics and printed electronics. Romano noted that LCR Hallcrest felt there was a need for a reliable, low cost battery tester that could service both 1.5V and 9V batteries.

“Hallcrest had seen several earlier attempts by others but none could service the conflicting requirements of handling the wide difference in power density between 1.5V and 9V batteries, the accuracy and low cost at the same time,” Romano said. “Hallcrest had the experience in the thermochromatic materials area, and we felt we could learn the heat transfer and electrical circuit aspects of the product design.”

By designing a robust, low cost easy-to-use system that has no mechanical parts, LCR Hallcrest has developed an accurate tester at an excellent price point. Romano noted that there were several technological hurdles to be overcome. LCR Hallcrest’s R&D personnel had to determine the proper set points for the tester that matched to the targeted battery types; develop the heat transfer/electric circuit model for the product layout; and select and formulate the resistive inks to satisfy the requirements of the printing process and the heat transfer/electric circuit model.

Once that was accomplished, the company then created the product prototype tester, used the heat transfer/electric circuit model to investigate cost reduction design options and finalized the design.

In terms of manufacturing, LCR Hallcrest created the artwork, formulated and printed the thermochromic inks.

Romano said that printing of the resistive ink heating blocks is a major facet of the process.

“The single most critical capability is the ability to print the thicknesses of the resistive inks as consistently as possible, both within a single tester and across all of the testers,” he noted. From there, the resistive blocks are oven cured, and the conductive traces are printed over the resistive blocks, followed by oven curing of the conductive traces. Next, a protective dielectric overcoat is printed on the thermoelectric circuit, followed by printing of the color window on the reverse side of the tester directly under the resistive blocks. The thermochromatic ink is then printed directly over the color window. Any non-functional graphics material is then printed onto the tester before the final cutting and packaging.

The expertise that LCR Hallcrest brings to the thermographics field is very much on display throughout the entire process.

“LCR Hallcrest is the largest manufacturer of color changing materials, including liquid crystal, leuco dyes and photochromic ink products, both reversible and non-reversible, offering not only an extensive portfolio of standard products but custom solutions and a consultative approach

to solving communication problems,” Romano noted. “Our new Household Battery Tester represents the first commercial release of a device that is a completely printed conductive circuit with a thermographic display.”

The ability to work closely with customers is another hallmark of LCR Hallcrest.

“We routinely cooperate in the development of advanced printing techniques/products during the application of our products,” Romano said. “We recently created a Hybrid Solvent Liquid Crystal Ink for high speed gravure presses in reaction to a customer’s need for a touch

sensitive color change application; that is, the ink changes color when touched on the consumer package.”

Overall, Romano sees tremendous possibilities for printed electronics.

“We believe the potential is endless and in its infancy,” Romano said.

“The combination of these two technologies creates an interactive package, label or graphic communication device that has the ability to engage the audience or perform a diagnostic test at a low cost. Thermochromic inks respond to temperature and create an interactive element to printing. Combine this with a printed electronic circuit and you now have the ability to print a smart functional device that can display messages, perform diagnostic tests or simply entertain your audience.”

