Aluminum foil lamps outshine incandescent lights

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Researchers at the University of Illinois are developing panels of microcavity plasma lamps that may soon brighten people's lives. The thin, lightweight panels could be used for residential and commercial lighting, and for certain types of biomedical applications.

"Built of aluminum foil, sapphire and small amounts of gas, the panels are less than 1 millimeter thick, and can hang on a wall like picture frames," said Gary Eden, a professor of electrical and computer engineering at the U. of I., and corresponding author of a paper describing the microcavity plasma lamps in the June issue of the *Journal of Physics D: Applied Physics*.

Like conventional fluorescent lights, microcavity plasma lamps are glow-discharges in which atoms of a gas are excited by electrons and radiate light. Unlike fluorescent lights, however, microcavity plasma lamps produce the plasma in microscopic pockets and require no ballast, reflector or heavy metal housing. The panels are lighter, brighter and more efficient than incandescent lights and are expected, with further engineering, to approach or surpass the efficiency of fluorescent lighting.

The plasma panels are also six times thinner than panels composed of light-emitting diodes, said Eden, who also is a researcher at the university's Coordinated Science Laboratory and the Micro and Nanotechnology Laboratory.

A plasma panel consists of a sandwich of two sheets of aluminum foil separated by a thin dielectric layer of clear aluminum oxide (sapphire). At the heart of each lamp is a small cavity, which penetrates the upper sheet of aluminum foil and the sapphire.

“Each lamp is approximately the diameter of a human hair,” said visiting research scientist Sung-Jin Park, lead author of the paper. “We can pack an array of more than 250,000 lamps into a single panel.”

Completing the panel assembly is a glass window 500 microns (0.5 millimeters) thick. The window’s inner surface is coated with a phosphor film 10 microns thick, bringing the overall thickness of the lamp structure to 800 microns.

Flat panels with radiating areas of more than 200 square centimeters have been fabricated, Park said. Depending upon the type of gas and phosphor used, uniform emissions of any color can be produced.

In the researchers’ preliminary plasma lamp experiments, values of the efficiency – known as luminous efficacy – of 15 lumens per watt were recorded. Values exceeding 30 lumens per watt are expected when the array design and microcavity phosphor geometry are optimized, Eden said. A typical incandescent light has an efficacy of 10 to 17 lumens per watt.

The researchers also demonstrated flexible plasma arrays sealed in polymeric packaging. These devices offer new opportunities in lighting, in which lightweight arrays can be mounted onto curved surfaces – on the insides of windshields, for example.

The flexible arrays also could be used as photo-therapeutic bandages to treat certain diseases – such as psoriasis – that can be driven into remission by narrow-spectrum ultraviolet light, Eden said.

Source: University of Illinois at Urbana-Champaign