This article explores ceramic metal halide, a conventional technology still evolving despite the LED revolution, and discusses its specifics, history, most recent developments, and future outlook.

Ceramic metal halide: past present and future

by Henk Rotman, Philips Lighting

Of all the existing conventional lamps, the ceramic metal halide lamp is still the most “alive”: it is still improving in terms of performance (not only in terms of efficacy – other parameters are also improving). Manufacturers are still bringing new models to market (e.g. the Philips MasterColour Evolution, introduced in early 2013) and sales are still growing.

What are metal halide lamps?

Metal halide lamps are an outgrowth of mercury vapour lamps. The fundamental difference between the two is the fact that metal halide lamps contain halide salts such as scandium, sodium, thallium and indium. These salts are added to improve the spectrum, which leads to improvements in parameters such as lamp efficacy and colour rendering.

The burner used in most metal halide lamps consists of quartz. A major drawback of using quartz burners in metal halide lamps is a colour shift towards the end of the lamp’s life, mainly towards green. This can be seen in many places where quartz metal halide lamps are used, in both industry and retail.

What causes this colour shift? The halide salts inside the burner are the culprits as they interact with the quartz glass. A solution to this problem is to use a ceramic burner, as ceramics is resistant to the attack of the metal halide salts and, as a consequence, fully eliminate colour shift.

A short history of (ceramic) metal halide lamps

The concept of adding salts to mercury vapour lamps dates from 100 years ago and was realised by the “Wizard of GE”, Charles Proteus Steinmetz. However, it took 50 years before the first reliable metal halide lamp was created by another GE employee, Robert Reiling, using developments from the mercury vapour lamp such as the fused quartz discharge tube and tungsten sealed electrodes.

UK company Thorn showed the very first ceramic metal halide lamp at the 1981 Hanover fair. It was named the “TSH” lamp and offered 93 lm/W and offered a CRI > 70.

The TSH lamp, however, was not brought to market as it required dedicated ballast. It took another 13 years before Philips unveiled its MasterColour CDM range of ceramic metal halide lamps. These could operate on the same ballast as quartz metal halide lamps. The CDM lamp fully eliminates any risk of colour shift, and therefore offers crisp, white light, a lamp efficacy of up to 90 lm/W, colour rendering of more than 80, and 12 000 h lifetime. One of the challenges the Philips engineers had to overcome was the feed-through of wires from the electrode through the burner. Here, the company used the experience from their SDW-T (“White Son”) very high pressure sodium lamps, and came up with the protruding plug which creates distance between the seal and the heat of the arc tube.

Development of ceramic technology

In the period after 1994, the market witnessed the following five developments:

- Philips rolled out the CDM technology in many lamp shapes, including many shapes with incorporated reflectors, such as the PAR versions and the R111 versions.
- From 2001 onwards, other lamp suppliers also brought their ceramic lamps to market.
- In terms of miniaturisation, a new lamp wattage (20 W) and miniaturised lamp shapes were introduced: a shape with PGJ5 lamp foot and a maximum length of 52 mm and a shape with GU6.5 lamp foot and a maximum length of 56.7 mm. These lamps shapes were later also offered in 35 and 50 W. The driving force behind the miniaturisation was to seize the market sector previously served by halogen technology.
- Ceramic lamps were introduced specifically for outdoor use. These lamps can be split into retrofit lamps and lamps requiring specific

Fig. 1: Miniaturised ballast for CMH lamps.
Luminaires. CMH retrofit lamps are meant to replace high pressure sodium lamps directly and to bring white light and good colour rendering into installations originally lit by HPS. The switch from HPS to CMH had a positive effect on safety and the environment, and CMH is often implemented in city centers. For new installations, lamps with PGZ12 lamp foot are introduced (e.g. the Philips CosmoPolis). These lamps are designed for outdoor use as energy-saving alternatives for mercury vapour and both high and low pressure sodium. They are to be operated on electronic control gear and to be used in dedicated optics. These lamps have also recently been made available in an E27/E40 version as direct retrofit with HPS (gear change is, however, necessary).

- In terms of performance improvement, the specifications of CMH lamps have been improved step-by-step since their introduction in 1994, and these can be seen in the MasterColour lamps for indoor use. Philips has introduced two new ranges, the CDM Elite and the CDM Evolution. Compared to the original CDM, the Evolution offers a 25% higher light output, better colour rendering and lumen maintenance, as well as a 66% longer lifetime.

Controlgear

Developments in the controlgear for CMH has further popularised this category of lamp. Metal halide lamps were traditionally operated on magnetic controlgear. The upgrade from quartz to ceramic lamps improved the lighting quality substantially. However, the problem of lamp flicker remained. The introduction of electronic controlgear for CMH has eliminated the risk of lamp flicker as the lamp frequency was increased beyond what the human eye can detect (most ECGs for CMH operate around 130 Hz). The technology is different from that used in ECGs for fluorescent lamps (where high frequency technology is common). High frequency technology can cause acoustic resonance in the lamp burner, causing the lamp to extinguish or to break down.

Other advantages of electronic operation for CMH lamps are:
- It is a one-piece unit.
- Better handling of voltage fluctuations (with a positive effect on lamp life).
- Optimal end-of-life behavior.
- Miniaturisation (the volume of the smallest Philips ECG available today is only 20% that of the first ECG introduced in 1995).
- Flexibility: multi-wattage ballast have entered the market.

Development outlook

Experts agree that ceramic metal halide technology is still able to progress in terms of lamp efficacy, lumen maintenance and lifetime. The greatest advances will be achieved when a system approach is used: lamps, controlgear, controls and luminaires developed and optimised together. This could mean the development of a “closed system” (lamp + controlgear from a single supplier), which is not always accepted by the market, and should therefore be checked carefully.

Conclusion

In conclusion, we can state that CMH is a strong proposition for the lighting market today, and that it remains a strong “competitor” for that other evolving technology, LED, in the short term.

Contact Henk Rotman, Philips Lighting Africa, Tel 011 471-5000, henk.rotman@philips.com