Technology Focus

New Ceramic Capacitor Takes on Noise, Smoothing of LED Bulbs

As today's electronic devices are being required to be compact, thin, energy efficient, to have low noise, and to be eco-friendly to contribute to the prevention of global warming, light-emitting diode (LED) bulbs emerged in 2009 in response to these needs. Nowadays, LED bulbs feature compact and thin design and are highly eco-friendly with long durability. Therefore, electronic parts mounted on LED bulbs are also expected to be compact and thin with long durability. As an LED bulb is equipped with small power capacity of around 10W, cases are increasing where compact and highly durable ceramic capacitors are being used for smoothing, which used to be performed by electrolytic capacitors or film capacitors.

Murata Manufacturing Co., Ltd. has developed a ceramic capacitor made of a new material, which can acquire higher capacitance in actual use than conventional ceramic materials. In this article, the properties of the new ceramic capacitor material are being introduced as well as the circuit Murata recommends to use for the power section of LED bulbs and other electronic devices.

Performance Measured

The ceramic capacitor made of a new material has been made to change into the paraelectric phase in the room temperature range (25°C) by shifting the Curie point to lower temperatures than that of a conventional material. As a result, products made of a new material have achieved the following performances:

(1) The reduction ratio of capacitance when DC voltage is applied is so small that high effective capacitance can be secured. When DC 600V is applied, a capacitance twice as large is ensured (Fig. 1).

(2) The dielectric loss is small and the allowable current capacity is large. At a frequency of 250kHz, an allowable current capacity approximately 1.6 times as large is achieved. Under the company's standard on allowable current capacity, power can be applied until a capacitor heats up by itself up to 20°C at an ambient temperature of 25°C. A product with capacitance of 1µF has current capacity up to 4.7Arms if it is made of the new material and up to 2.9Arms if it is made of a conventional material at a frequency of 250kHz (Fig. 2).

(3) The mechanical deformation and noise (sound pressure level) is comparatively small at the application of DC voltage. The sound pressure is one-fifth of conventional products. Ceramics made of

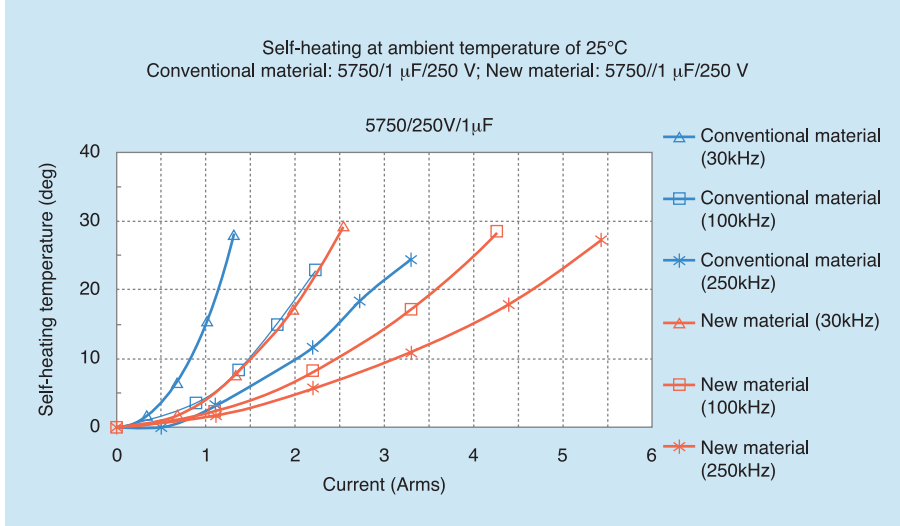

Fig. 2: Comparison of self-heating

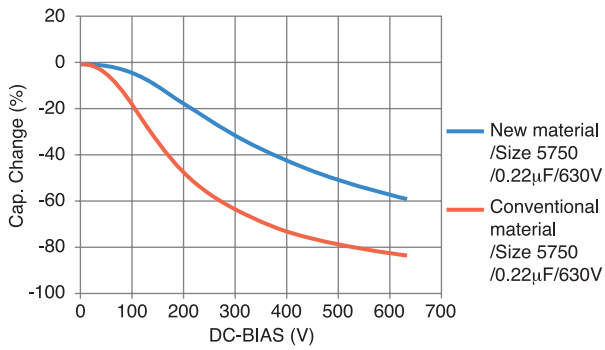

Fig. 1: Capacitance – DC voltage properties

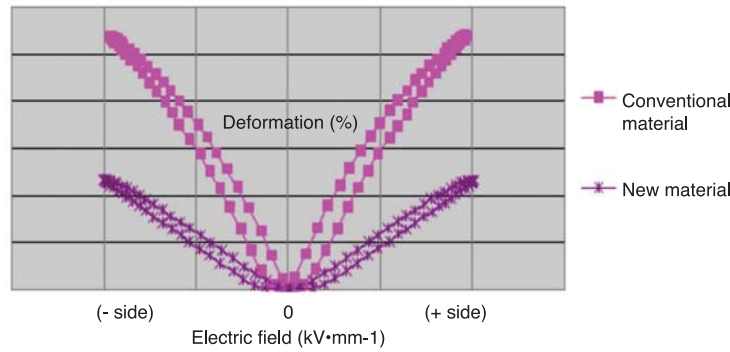

Fig. 3: Comparison of deformation

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a new material have small piezoelectric properties, which prevent occurrence of mechanical vibration caused by change of electric signals (Fig. 3).

A reduction of 6dB in sound pressure means that sound pressure is decreased by half. The difference between capacitors made of the new material and conventional one is 15dB or more, meaning the sound pressure has decreased by one-fifth (Fig. 4).

Product Lineup, Circuits Used

As of October 2010, the commercial preparation of ceramic capacitors made of a new material in the range as shown in Table 1 has been completed. In addition, a maximum capacitance of 2μF (= 1μF × 2) for products with rated voltage of DC 250V, 1.1μF (= 0.56μF × 2) for products with rated voltage of DC 450V, and 0.54μF (= 0.27μF × 2) for products with rated voltage of DC 630V can be achieved by preparing double-layer ceramic capacitors with lead wire or metal terminals to the market. The temperature properties of the ceramic capacitor made of a new material are X7T compared to X7R of ceramic capacitors made of a conventional material.

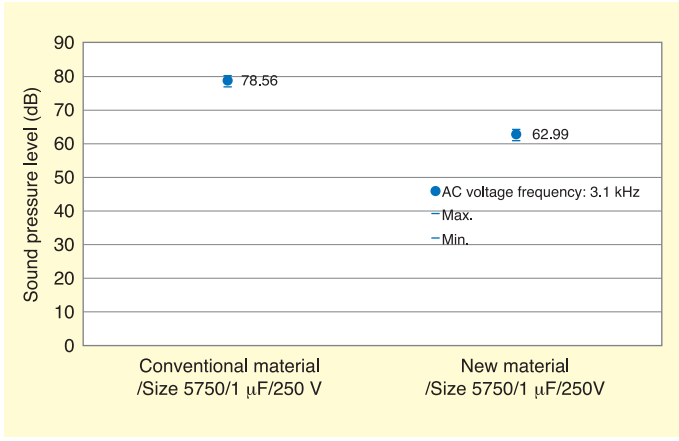

Fig. 4: Comparison of sound pressure level (based on Murata's measurement)

Table 1: Product lineup and their respective capacitance

Rated voltage	Size (L mm × W mm)	Capacitance (μF)									
		0.047	0.068	0.1	0.15	0.22	0.33	0.47	0.68	1	2
DC250V	3.2 × 1.6										
	3.2 × 2.5										
	4.5 × 3.2										
	5.7 × 5.0										
DC450V	3.2 × 1.6										
	3.2 × 2.5										
	4.5 × 3.2										
	5.7 × 5.0								0.56		
DC450V	4.5 × 3.2										
	5.7 × 5.0						0.27				

Figure 5 shows a general circuit diagram of an LED bulb.

Products made of a new material have higher effective capacitance than conventional products and have large allowable power capacity with high allowable ripple current. Thus, they can be used not only as countermeasures against noise, but also for smoothing application in small-capacity power supplies including LED bulbs, designed to be most appropriate to C4 and C5 circuits in Figure 5.

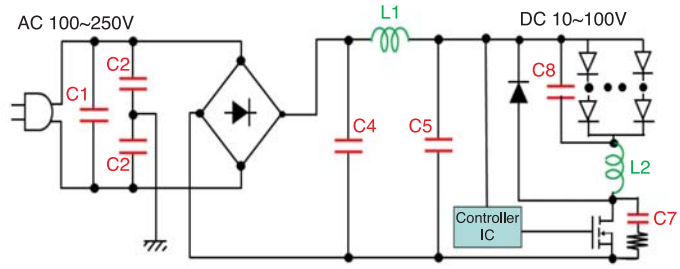

Fig. 5: Circuit diagram of power section

Table 2: Capacitors for other circuits

Circuit	Use	Chip type	Lead type	Radial lead type
C1	X capacitor	GA3/Type GB(X2) AC250Vrms		
C2	Y capacitor	GA3/Type GF(Y2) AC250Vrms	DE1/Type KX(Y1) AC250Vrms	
C7	SW snubber	GRM/U2J/DC250 ~630V		
C8	Output smoothing	GRM/X7R/DC25 ~100V		RDE/X7R/DC25 ~100V

In terms of concrete selection of capacity, to an actual equipment for domestic use with AC 100V, the potential difference between plus and minus immediately after the rectifier circuit is 140Vo-p (= 100 × √2). Therefore the maximum capacity up to 2μF can be selected for the products with rated voltage of DC 250V. Similarly, to an actual equipment for worldwide use with AC 240V, the potential difference is 340Vo-p (= 240 × √2) and therefore the maximum capacity up to 1.1μF can be selected for the DC 450V products and up to 0.54μF for the DC 630V products.

There are some cases where LED bulbs as well as LED lighting equipment may be attached with the power factor correction (PFC) circuit immediately after the rectifier circuit in response to the harmonics and PFC regulations. The products made of a new material can be used as PFC input capacitors as well as they have less dielectric loss than the conventional ones with excellent allowable ripple current.

Other capacitors which can be used for C1, C2, and other circuits are shown in Table 2 for reference.

Conclusion

The capacitors made of the new material have been developed and prepared for the market aiming at less dielectric loss and larger capacity. They are most appropriate as countermeasures against noise and for smoothing in circuits. Murata Manufacturing will update the necessary technical data, for example, data on allowable current capacity, and offer information to promote the product's further ease of use.

About This Article:

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