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Electric Matches: Physical Parameters

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Introduction

A major study of electric match sensitiveness was recently completed.[1] This article continues that work and presents a compilation of the physical parameters (as measured and/or provided by the suppliers) for the same collection of 10 electric match types as in the previous article.

Nominal Tip and Shroud Size

For each electric match type, five matches were selected at random, and their dimensions (maximum thickness, width, and length) were measured using a caliper. However, because of the limited number of matches measured and because of the variability in the size of the electric match tips, the averages of these values are only reported to the nearest 0.01 inch in Table 1. For those electric match types provided or available with shrouds, the measured diameter and length of those shrouds are also reported.

The size of the electric match tips fall roughly into three groups. The largest tips are the Aero Pyro, all three Daveyfires, the Luna Tech OXRAL, and the Martinez Specialty E-Max and Titan electric matches. Slightly smaller are the Luna Tech BGZD and Flash electric matches. Smaller still are the Martinez Specialty E-Max Mini electric matches. While the lengths of the shrouds (where provided by the supplier) varied, all but one had a diameter of approximately 1/4 inch. A smaller shroud, a little less than 3/16 inch is available for the Martinez Specialty E-Max Mini electric matches.

Table 1. Average Electric Match and Shroud Dimensions.

Supplier Name	Product Designation	Tip Dimensions (in.)[a]			Shroud Dimensions (in.)	
		Thick.	Width	Length	Diameter	Length
Aero Pyro		0.13	0.16	0.50	n/p	n/p
Daveyfire	A/N 28 B	0.11	0.14	0.46	0.24	0.71
	A/N 28 BR	0.13	0.15	0.50	0.24	0.71
	A/N 28 F	0.11	0.14	0.47	0.24	0.71
Luna Tech	BGZD	0.10	0.13	0.47	n/p	n/p
	Flash	0.10	0.13	0.45	n/p	n/p
	OXRAL	0.09	0.19	0.42	0.25	1.03
Martinez Specialties	E-Max	0.09	0.15	0.46	0.22[b]	0.60
	E-Max-Mini	0.08	0.11	0.34	0.16[c]	0.61
	Titan	0.11	0.15	0.45	0.22[b]	0.60

"n/p" means the electric match was "not provided" with a shroud from the supplier.

(a) Electric match tip size is the average of measurements made on 5 tips and is reported to the nearest 0.01 inch.

(b) This shroud is a short length of soft rubber (plastic) tubing. The stated diameter (0.22 inch) is that of the tubing before the electric match is inserted. Upon insertion of the electric match, the tubing takes a somewhat oval shape with the minor and major diameters of 0.22 and 0.26 inch, respectively.

(c) This shroud is a short length of soft rubber (plastic) tubing. The stated diameter (0.16 inch) is that of the tubing before the electric match is inserted. Upon insertion of the electric match, the tubing takes a somewhat oval shape with the minor and major diameters of 0.16 and 0.17 inch, respectively.

Composition Mass and Bridgewire Configuration

The mass of composition, including the protective coating, was determined for the electric match types. This was accomplished by selecting a single, typical match tip, weighing it, soaking the match tip in acetone and agitating until all of the composition was removed, and then reweighing the match tip after drying. The composition mass results are listed in Table 2. Because only a single electric match tip of each type was examined, it was felt to be appropriate to report the results to only one significant figure.

Table 2. Electric Match Composition Mass and Tip Design.

Supplier Name	Product Designation	Comp. Mass (mg)[(a)]	Tip Type[(b)]
Aero Pyro		80	1
Daveyfire	A/N 28 B	40	1
	A/N 28 BR	80	1
	A/N 28 F	80	1
Luna Tech	BGZD	10	1
	Flash	20	1
	OXRAL	40	3
Martinez Sp.	E-Max	20	2
	E-Max-Mini	6	1
	Titan	20	2

For conversion to English units, 1 grain equals 65 mg.

(a) Composition mass was determined for only one electric match tip and is reported to only one significant figure.

(b) Tip types 1, 2 and 3 are illustrated in Figure 1.

Three basic bridgewire configurations were found for the electric match tips. The numbers indicating the three configurations are designated in Table 2 and correspond to the numbers in the three illustrations in Figure 1. Figure 2 is a series of electron micrographs of the three bridgewire types. In Types 1 and 2, the bridgewire is soldered to the copper cladding. In Type 2, a small portion of the end of the electric match tip has been removed by milling, prior to the addition of the bridgewire. In Type 3, the bridgewire is held (crimped) under a fold of two brass support posts.

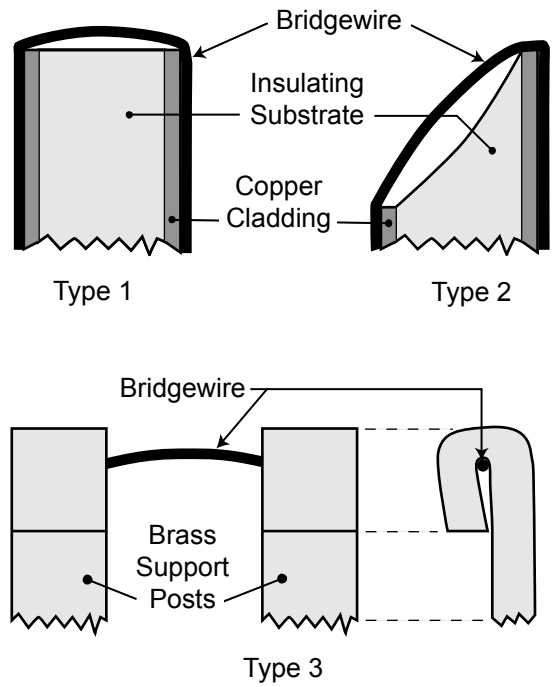


Figure 1. Illustrations of the basic bridgewire configurations of three styles of electric matches (not to scale). Types 1 and 2 are side views shown in cross section; type 3 is shown in both a frontal and a side view.

While the amount of composition on electric match tips is potentially related to its ability to produce ignitions, often it is not a good indicator. This is because there can be large differences in the density and effectiveness of the various compositions. Further, it is thought that the configuration of the electric matches (Types 1, 2, or 3) has little if any bearing on their performance. Information on the electric match's ability to produce ignitions will be presented in a subsequent article.

Electrical Parameters

Resistance measurements were made on a collection of 10 match tips, each with 5-inch leg wires attached tightly to the measuring instrument. The instrument used produced results to 0.1 ohm, was nulled for 0.0 ohm and produced a correct reading for a 1.00-ohm NBS calibrated resistance. The results of these resistance measurements are reported in Table 3. The suppliers were asked for information about the no-fire, all-fire, and recommended firing currents for their

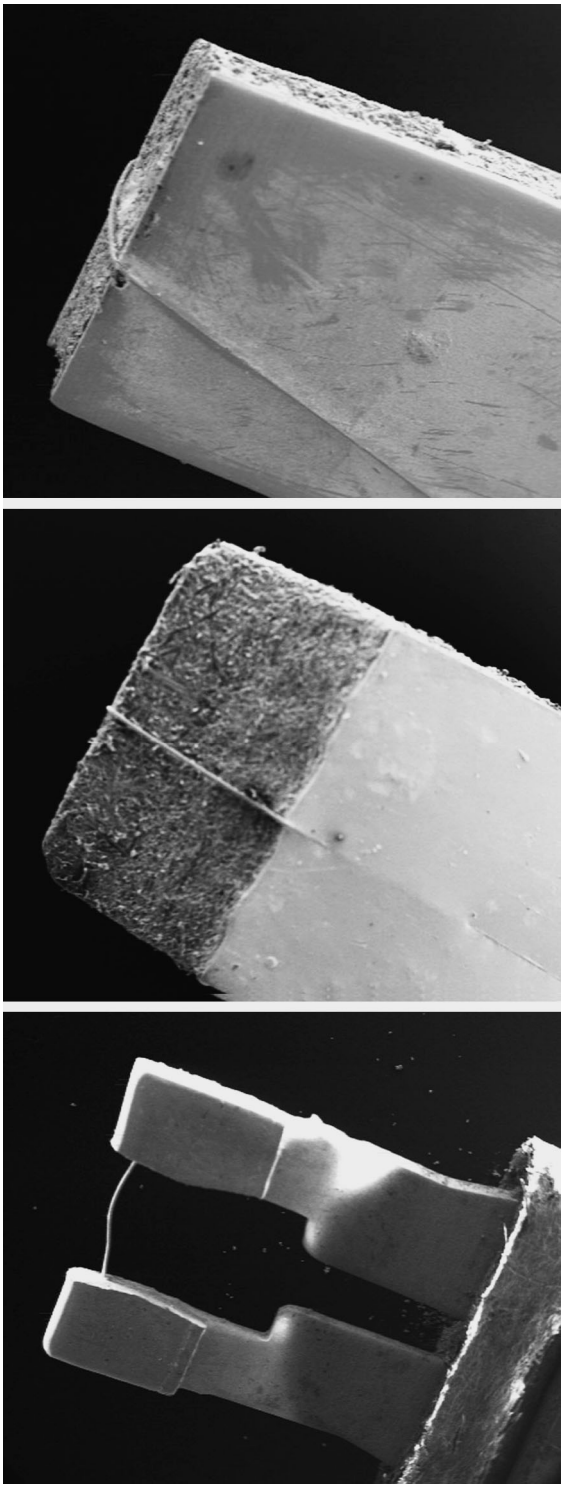
electric matches. Where provided, these data are also presented in Table 3, along with notes giving additional or qualifying information.

Most often, electric match tip resistance is of little concern; however, an exception is when many matches are to be fired in a series circuit. In that case, for electric matches requiring approximately the same firing current, the higher the individual match resistance, the fewer matches that can be reliably fired with a given firing unit (firing voltage). The lowest electric match resistances (0.9 to 1.2 ohms) were found for the Aero Pyro, Luna Tech Flash, and Martinez Specialty E-Max Mini matches. The next higher resistances (1.6 to 1.7 ohms) were found for all three of the Daveyfire and the Luna Tech BGZD and OXRAL matches. The highest resistances (2.5 to 2.7 ohms) were found for the Martinez Specialty E-Max and Titan matches, which are the two types of electric match tips that were milled (Type 2).

In a subsequent article, one discussing the performance of the various electric matches, more information will be presented on their firing characteristics. Nonetheless, it is worth mentioning that the suppliers' recommended firing currents fall into two groups. One group (firing currents of 0.5 to 1.0 ampere) includes most of the matches; the other group (firing currents of 2.0 to 3.5 amperes) consists of the Daveyfire A/N 28 F, the Luna Tech Flash and the Martinez Specialty Titan matches. Note that in the previous article,[1] these were the three electric match types that tended to be significantly less sensitive to ignition by impact, friction and electrostatic discharge. This serves to illustrate that it is generally true that pyrotechnic materials that are less sensitive to accidental ignition also tend to be less easy to ignite intentionally.

Acknowledgments

The authors gratefully acknowledge that the four electric match suppliers provided samples of their products, at no cost, for testing. Further the American Pyrotechnic Association provided a grant to help cover some of the costs of this study. Finally the authors appreciate the technical comments provided by L. Weinman and M. Williams on an earlier draft of this article. Note that while many of the company and product



Electron micrographs of the three electric match bridgewire types: Top, Type 1; Middle, Type 2; Lower, Type 3.

Table 3. Electric Match Electrical Parameters.

Supplier Name	Product Designation	Resistance (ohms)[a]		Current (ampere)[b]		
		Average	Range	No-Fire	All-Fire	Recom.[c]
Aero Pyro		1.2	1.1–1.2	[d]	[d]	[d]
Daveyfire	A/N 28 B	1.6	1.5–1.6	0.20[e]	0.37[f]	≥0.90[g]
	A/N 28 BR	1.6	1.5–1.7	0.20[e]	0.37[f]	≥0.90[g]
	A/N 28 F	1.6	1.5–1.6	0.40[e]	1.20[f]	≥2.00[g]
Luna Tech	BGZD	1.6	1.5–1.7	n/p	n/p	≥0.5[h]
	Flash	1.0	0.9–1.0	n/p	n/p	≥3.5[h]
	OXRAL	1.7	1.7–1.8	n/p	n/p	0.5 / 0.8[i]
Martinez Sp.	E-Max	2.5	2.4–2.8	0.20[j]	0.35[k]	0.5 / 0.9[l]
	E-Max-Mini	0.9	0.8–1.1	0.30[j]	0.50[k]	0.75 / 1.0[l]
	Titan	2.7	2.5–2.9	0.35[j]	0.50[k]	1.0 / 2.0[l]

"n/p" means data was "not provided" by the supplier.

(a) Tip plus 5-inch leg wire resistance for a collection of 10 electric matches.

(b) These values were not determined in this study; they were provided by the suppliers of the electric matches.

(c) "Recom." means firing currents recommended by the electric match supplier.

(d) Due to the untimely death of the owner of Aero Pyro, these values were not provided.

(e) This is the 10-second maximum no-fire current.

(f) This is the 40-millisecond minimum all-fire current.

(g) This is the recommended series firing current.

(h) This is the 50-millisecond specified minimum firing current.

(i) These are the "rated" and "series" firing currents.

(j) This is the 30-second maximum no-fire current.

(k) This is the 1/2-second minimum all-fire current.

(l) These are the recommended "minimum" and "normal" firing currents.

names are apparently registered trademarks, they have not been specifically identified as such in this article.

References

1) K. L. and B. J. Kosanke, "Studies of Electric Match Sensitiveness", *Journal of Pyrotechnics*, No. 15, 2000; also appearing in this collection of articles.