A156 Significance of Match Criteria for Refractive Index Comparison of Glass Fragments

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After attending this presentation, attendees will obtain an appreciation of the relationship between commonly used match criteria for refractive index of glass and the frequency at which a recovered fragment or fragments are incorrectly not matched with their true source for typical panes of float glass.

This presentation will impact the forensic community by discussing how the majority of forensic laboratories currently use some form of hypothesis testing for comparison of RI between samples. In most instances, a confidence interval about a central value is determined by repeated measures of a sample of known origin (here referred to as K) and values measured for recovered fragments (Q), either individually or grouped, are compared to this interval. Common statistical tests are used for this comparison, sometimes without consideration of the underlying requirements or assumptions of the test. There is currently a high level of interest in defining a standardized procedure for these match criteria that can be used by a number of forensic practitioners. In a study to be discussed in this presentation, repetitive random selection of measurements from each of five sheets of float glass were used to assess eight match criteria as to the frequency in which a fragment fails to be associated with its correct source.

Five glass sources were utilized for this study, two sheets of a double paned residential window, one automobile side window, and two sheets of a laminated automobile windshield. All five samples were float glass. The automobile side window was tempered and the other four samples were not. Sample fragments were selected from each of the four quadrants of each sheet. From within each quadrant, five fragments were selected, washed with nitric acid, crushed, and mounted in silicone oil (Oil B, Locke Scientific) on slides for measurement of refractive index. For each prepared slide, at least ten measurements of RI were obtained at the 589-nm wavelength (n_D) using an automated glass refractive index measurement instrument (GRIM3, Foster and Freeman). The first ten edges that were of good quality were selected for measurement. Edges corresponding to the original glass surface were avoided and no two measurements were made from the same edge of a fragment. Using this procedure, at least 200 measurements were made from scattered locations throughout each glass source. Prior to making analytical measurements, the instrument was calibrated using seven glass standards (B Series, Locke Scientific) to obtain a linear response between n_D values at 20C and the match temperature. Accuracy of the results was checked daily using a reference glass standard material (NBS 9012).

The 200+ results for each source were used to select data representing K and Q glass fragments for evaluation of eight match criteria that have been used in forensic laboratories. The match criteria tested consisted of confidence intervals based on range, range +0.00005, mean +1 standard deviation, mean +2 standard deviations, t-test at 95% confidence, t-test at 99% confidence, mean +0.0001, and mean +0.0002 (Miller criterion). Each test was performed 1000 times for each glass source by random selection with replacement from the measured values. The effects of the number of measurements were determined by performing each statistical test at a number of recovered glass measurements of 5, 6, 7, 8….20, 25, 30, and 40 and the number of questioned fragments of 1 and 3, i.e., 19 levels of K by 2 levels of Q by eight statistical tests, repeated 1000 times.

The error rates differ from those that might be predicted by statistics for some tests, probably as a result of minor deviations from normality in the distribution of the measured values. Predictably, the number of replicate measurements on the K sample has a significant effect on the error rate for some of the tests. Also, when three measurements of the Q glass are averaged together and compared to the K glass, the number of Type 1 errors is smaller than when only a single measurement of the Q glass is used.

Glass, Refractive Index, Match Criteria

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