TECHNICAL NOTE

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Three-Dimensional Presentation of Glass Density Versus Refractive Index Data

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ABSTRACT: Graphical representations of glass density versus refractive index data have classically been in the form of two-dimensional scattergrams. For the purpose of illustrating how common or uncommon a particular glass sample is, a three-dimensional projection graph has been found to be useful.

KEYWORDS: forensic science, glass, refractive index, density (mass/volume)

In cases involving glass evidence, the forensic scientist has two options with respect to the formulation and conveyance of an opinion whenever the evidence and the exemplar glass agree in density and refractive index. The first option is to state simply that the glass agree closely in optical and physical properties and are therefore consistent with having shared a common origin; in this option no attempt is made to comment upon how common or uncommon the glass may be. In the second option, which is the option favored by the present writers, the interpretation may be carried a bit farther by commenting upon how common or uncommon those properties are when projected against previous experience.

Under this option, a glass sample with a density of 2.495 (± 0.001) and a refractive index of 1.5185 (± 0.0002) would be described as a fairly prosaic sort of glass, while a sample with a density of 2.500 and a refractive index of 1.5210 would be described as unusual. This sort of commentary requires, however, an extended set of previously developed data. The data set that is most frequently used for this purpose is that developed by the FBI Laboratory; certainly it is the most comprehensive glass density and refractive index data set for forensic science purposes available. It has been widely distributed informally in the form of a computer printout,[2] and various scattergrams of these data have been published [*1,2*].

In the experience of the present authors, however, two-dimensional scattergrams are an ineffective means of attempting to convey to a lay jury just how common or uncommon a particular sample of glass actually is. Although there is nothing very difficult conceptually in

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[2]Elmer T. Miller, personal communication, FBI Laboratory, 1979.

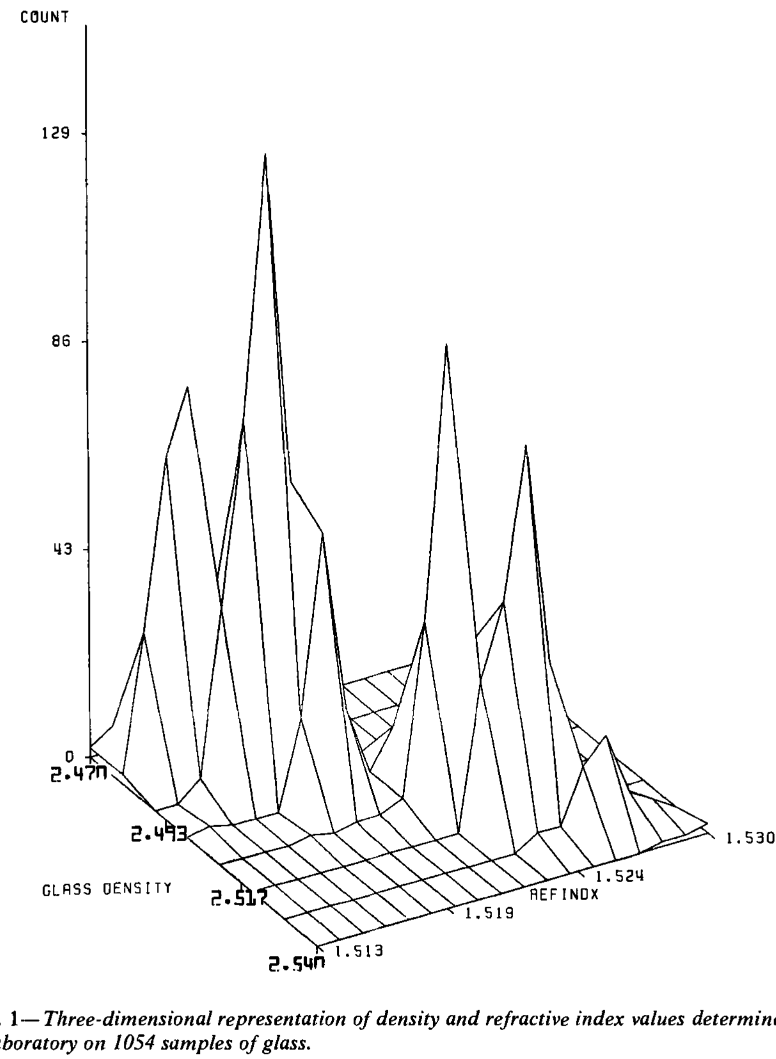

FIG. 1—*Three-dimensional representation of density and refractive index values determined by the FBI Laboratory on 1054 samples of glass.*

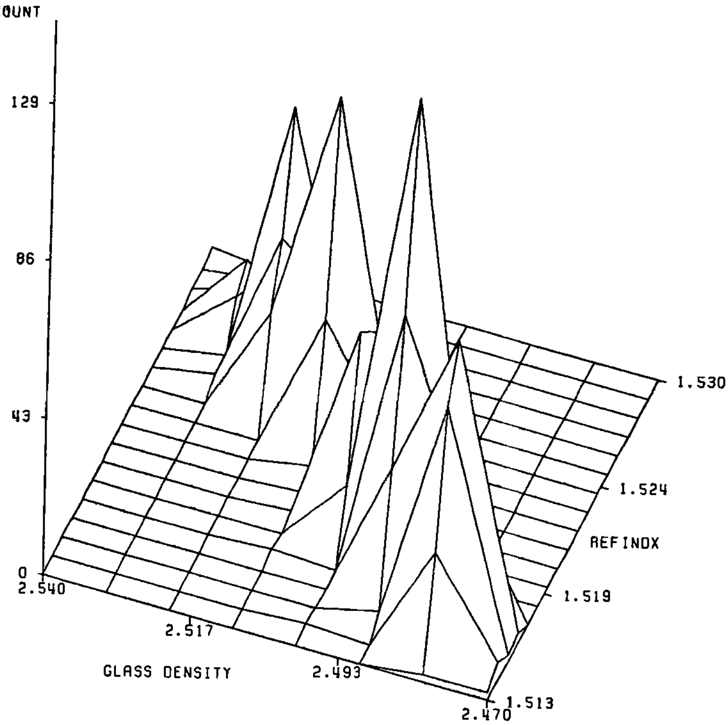

FIG. 2—*Three-dimensional representation of glass density and refractive index data. The data are the same as that depicted in Fig. 1, but the axes have been rotated by the SASGRAPH routines to display another projection.*

the interpretation of a scattergram, they are best read by those individuals who already know what a scattergram is; jurors frequently have little or no experience in doing so.

Frequency distributions may be graphically illustrated by other devices, however. One device which the writers have found to be effective in conveying the essence of a distribution is a three-dimensional topographic surface. A three-dimensional surface may be generated by computer, and seems to more easily convey the message concerning the distribution to a relatively unsophisticated audience. In such a three-dimensional graph, the third dimension represents the count, or the frequency of occurrence of particular values of both density and refractive index. Using an edited set [*3*] of the FBI data, a SASGRAPH[3] program transposed the density and refractive index (for the D line of sodium) data and plotted the three-dimensional distribution. This plot is illustrated in Figs. 1 and 2. In actual case situations, the density and refractive index values in question may be related to one of the rotational forms of this three-dimensional surface. It may then be explained to the jury that the higher on a peak the glass is situated, the more common that particular glass is. The lower on a peak, or the further out on the foothills that the glass is situated, the more uncommon that particular glass is. This mode of presentation seems to be easily grasped by individuals who are unsophisticated with respect to the graphical representation of data. The SASGRAPH programs include routines that allow for the virtually unlimited rotation of the projections (as between Figs. 1 and 2) to ensure that the glass in question may be positioned on a surface which is visible. Upon request, the authors will furnish in a 20- by 27-cm format a set of the two figures above and two additional rotations.

[3]SAS Institute, Inc., SAS Circle, P.O. Box 8000, Cary, NC 25711.

References

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