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Analysis of Inter-Particle Distance Distribution in a Diamond Sawing Blade

Hyun-Woo Lee and Yong-Seog Kim*
Shinhan Diamond Industrial Co. Ltd, Incheon, Korea
*Dept. of Materials Science and Engineering, Hongik University, Seoul, Korea

Introduction

With recent improvements in mechanical properties of synthetic diamonds, new approaches to exploit the benefits of such advancements are required in the processing of diamond saw blades. Cutting efficiency of diamond particles on segment surface of the blade has been known to depend on the distribution of inter-particle distance. In this study, therefore, an attempt was made to analyze the distribution theoretically and compared with measured values.

Results and Discussion

Figure 1 shows distribution of the inter-particle distance between diamond particles predicted using a 2-dimensional theoretical model. As noted in the figure, the inter-particle distance skewed toward to smaller distances with tailing-off at longer distances. The distribution fits well with a Gamma or Weibull function, rather than by a normal distribution function. The diamond particles with shorter distance should have low cutting efficiency and increases cutting load. The diamonds with longer distance, on the other hand, should experience high cutting forces, promoting a premature pull-out from the segment. These results suggest that the random distribution of diamond particles may not be an efficient way of manufacturing cutting tools.

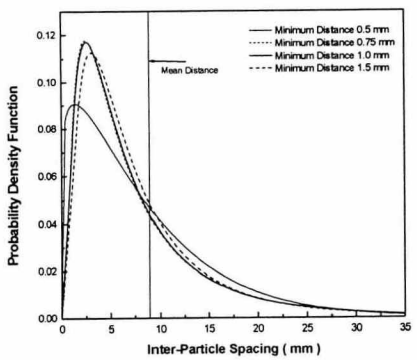

Fig. 1. Probability density function of inter-particle spacing with minimum distance (2-dimension distribution)

The inter-particle distance measured on segment surface. For this measurement, diamond particles on segment surface were classified into three categories: cutting diamond, fractured diamond, and pulled-out diamond.

The diamond was classified as cutting one when its remaining size is larger than 50% of its original size. Actual observation of the diamonds on conventional blades after cutting stones indicated that the ratio among the cutting, fractured, and pulled-out diamond is 5:4:1. The ratio remained almost the same irrespective of diamond contents and cutting speeds within the range investigated in this study. The distribution of inter-particle distance was similar to the distribution predicted theoretically. The distribution fitted well with the Gamma or Weibull functions as shown in Fig. 2. As the diamond particle content in the blade was increased, the distance and its deviation were measured to decrease. This phenomenon is attributed to a wider window of stead state cutting conditions with higher diamond content. The blades with lower diamond content, however, have larger deviations of inter-particle distance.

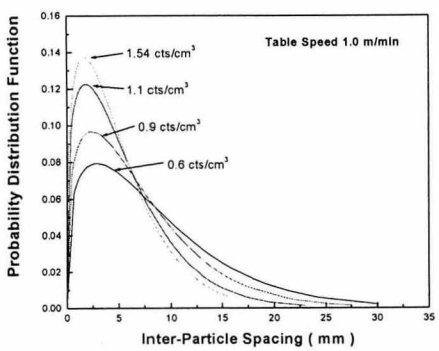

Fig. 2. Inter-particle distribution measured experimentally.

Summary

The inter-particle distance between diamonds on the segment surface of sawing blade predicted theoretically and measured experimentally followed a Gamma or Weibull function, rather than a normal distribution function. These results suggest that random dispersion of diamond particles in the segment may not be an efficient way of improving cutting efficiency of the blade.