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The Evolution of Synthetic Diamonds

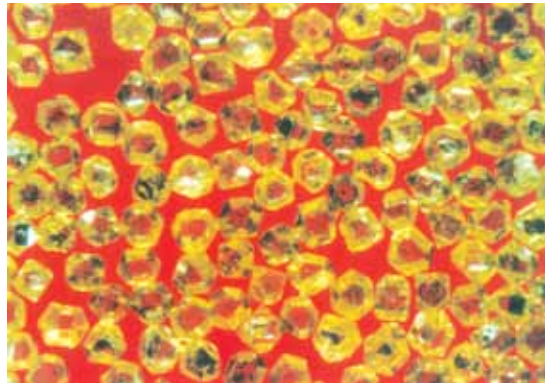
By Robert Hodson

Manufactured diamonds have been commercially available for over 50 years, but were not used extensively by diamond blade manufacturers until about the mid-seventies. The main reasons for this were that suppliers of natural (mined) diamonds convinced manufacturers for many years that their natural material was better, and simply because manufactured diamonds were more expensive.

From a technical viewpoint it was easy to see that the manufactured variety may prove to be better than the natural alternative, because the former were block-shaped, single crystals with far fewer internal flaws than the natural type. However, this remained undemonstrated on a large scale until the mid-seventies when, due to political upheaval in Africa, natural diamonds became in short supply and their price skyrocketed. Now, manufactured diamonds were not only less expensive, but were almost the only type of diamonds available.

Diamond blade manufacturers launched fast-track development projects to learn how to use the manufactured variety in their saw blade segments. These projects required changes to process parameters in order to minimize exposure of the diamonds to high temperatures and, in some cases, changes in metal bond chemistry. Overall, manufacturers found that the conversion was easier than expected. Once the changes were made, results were astonishing. Suddenly, hard materials were easier to cut, cutting rates went up and in many cases blade life improved.

Today, manufactured diamonds are used almost exclusively in metal-bond diamond saw blades. It is well known that man manufactures diamonds in a similar way as Mother Nature does, that is, by subjecting carbon to high temperatures and ultra high pressures. At the temperatures and pressures used, the carbon atoms are squeezed so closely together that new atomic bonding occurs and the atoms are locked into the diamond crystal structure. The transformation from carbon to diamond occurs within a molten metal matrix of either cobalt or iron-nickel alloy. The product recovered from the press is an odd shaped nugget of metal with diamond particles protruding all over. The metal is then leached away with acids and the diamond particles



are recovered and sorted by size, shape, and purity. Particle toughness is directly related to purity—the higher the purity, the higher the toughness.

Diamonds manufactured by the cobalt matrix method generally have inclusions called dendrites, which resemble tree branches. These inclusions have an effect on crystal “friability” or resistance to fracture. Friability is determined by subjecting the crystals to a crushing action using standard loads for standard time periods, then

measuring the weight loss. Diamonds manufactured by the iron-nickel matrix method also have inclusions, but usually not the dendritic variety. However, these inclusions also affect friability of the diamond.

Over the years, diamond makers have been working on ways to increase the yield of high purity particles in every batch of diamonds produced, with relative success. This has given diamond blade manufacturers another direction to take when the need to alter blade performance arises.

Another important development in manufactured diamond technology is the recent progress being made in coated diamonds. The purpose of using coated diamonds is to improve diamond retention in the metal bonds so that diamonds are not lost before they can be fully used. In the past, single layer coatings on diamonds were not effective due to incompatibility with either the diamond particles or the metal bond. The newer coatings now available are multi-layered, having one material in contact with the diamond particles and another material in contact with the metal bond. These new coatings are being used successfully in many applications.

In conclusion, out of necessity and the innovation of pioneering scientists, today’s synthetic diamonds are harder, stronger and less expensive than those produced 50 years ago. These diamonds are designed more for the specific purposes of concrete cutting, including increased blade life and more aggressive cutting techniques. These synthetic diamonds are more than capable of standing up to the ever-growing needs of the concrete sawing and drilling industry.

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