

Keen – a new concept in prealloyed powders

Prealloyed metal powders for diamond segment manufacture, were first introduced in 1997 and now have a 25% market share. This report describes a new prealloyed product specially developed for use in more demanding applications where segments with both high ductility and high hardness are required.

In 1997, French company, eurotungstene was the first to launch a range of prealloyed powders – called NEXT® – which created a quite a stir in the diamond toolmaking field. Prealloyed powders, composed of cobalt, iron and copper, were especially designed to give both technical and economical advantages to the diamond toolmaker.

A major technical advantage is excellent metal distribution, which offers much greater homogeneity than that achieved with standard mixtures. Prealloyed powders also allow for more simplified segment component mixing, and the enhanced quality of diamond retention and protrusion height are said to enhance tool performance.

Economically, the use of prealloyed powders enables reduced sintering temperatures to be used, which allow substantial savings to be made in processing costs in terms of diamond concentration, graphite usage and energy consumption.

The success of prealloyed powders can be seen in their current market share of the total metal powder business for diamond segment manufacture. After less than 10 years, this now stands at 25%.

New product launch

Like all innovative companies in the industrial diamond business, eurotungstene has continued to enhance and modify its product range. This has manifested itself in the launch of a new prealloyed powder called Keen®.

This product is intended for use in the manufacture of diamond sawblades and wire saws used for cutting concrete (green and reinforced), asphalt and the harder and more abrasive stones such as granite. These more extreme operations require a tool that has the right combination of hardness and ductility (toughness) and, in most cases, traditional cobalt powders are used in bond manufacture.

Keen, its makers claim, is the first product on the market to offer an alternative prealloyed solution.

Keen is very much a sister product to eurotungstene's NEXT range of prealloyed although they are aimed at different applications.

NEXT performs very well in cutting operations on materials where good hardness and free cutting are the key factors for excellent performance in the diamond tool.

In some applications, however, the actual prealloyed solution cannot reach optimum performance because of the limited ductility of the material. Keen provides this increased ductility (also known as impact strength or resilience) together with a similar level of hardness. Keen, therefore, is mainly aimed at applications that are more severe and where the ductility of the bond is a pre-requisite to having a good working tool.

Two different Keen products have been launched by eurotungstene to cater for all conditions and a wide range of additives is available to increase the versatility of this product.

Keen10:

This product exhibits similar behavioural characteristics to standard cobalt. It can be sintered at medium temperature (850 °C) and demonstrates a high level of ductility and a hardness comparable to standard cobalt. Its use is aimed at general construction applications.

Keen20:

This is a more high-tech product with outstanding mechanical properties (wear resistance and tool life) and a unique combination of hardness and ductility. It requires a high sintering temperature (950 °C minimum, 975 °C recommended) and is designed for high performance operations on the more severe materials.

Table 1 gives a comparison of the different properties of these two products and Fig 1 shows them in comparison to NEXT.

Sintering conditions

Extensive in-house tests were carried out to find out the optimum sintering temperatures to be used with these two new products (Figs 2 and 3). The temperatures were measured using a thermocouple. It can be seen that the optimum relative density and hardness values of Keen10 were achieved at a

sintering temperature of 850 °C, whereas the recommended value for Keen20 was 975 °C, although this can be as low as 950 °C. The company will supply sintering certificates on request.

Fig 4 shows a comparison of these two new Keen products with other products made by eurotungstene in terms of the variation in hardness with sintering temperature. From this it can be clearly seen where the Keen products position themselves with respect to the existing products, offering more alternatives to the customer.

Main properties

During the development and testing of Keen, these three main properties were selected as relevant to the characterisation of the metal matrix of diamond segments:

- ◆ hardness
- ◆ impact strength
- ◆ rupture deflection and rupture strength

A standard Charpy (non-unnotched) test was employed to obtain impact



Fig 1 Prealloyed powders from eurotungstene (from top) NEXT, Keen10 and Keen20

Property	Keen10	Keen20
Theoretical density (g/cm ²)	8.25	8.47
Oxygen (% wt)	0.5	0.3
Fisher (µm)	2.5	2.5
Cobalt content (%)	25	19
Sintering temperature (°C)	850	975

Table 1 Properties of Keen10 and Keen20

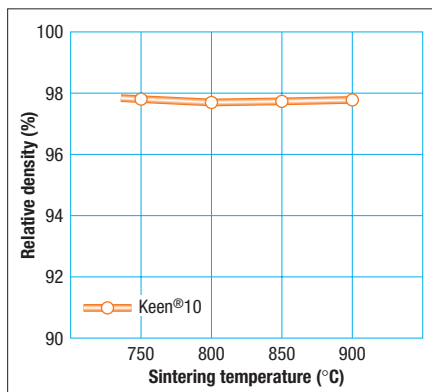


Fig 2a Variation of relative density with sintering temperature for Keen10

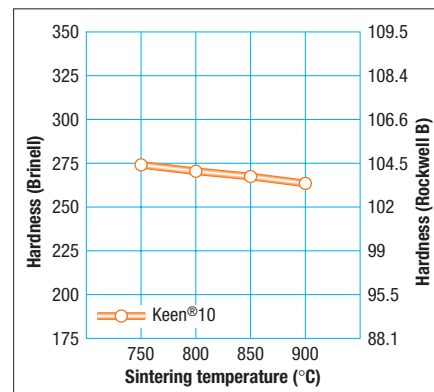


Fig 2b Variation of hardness with sintering temperature for Keen10

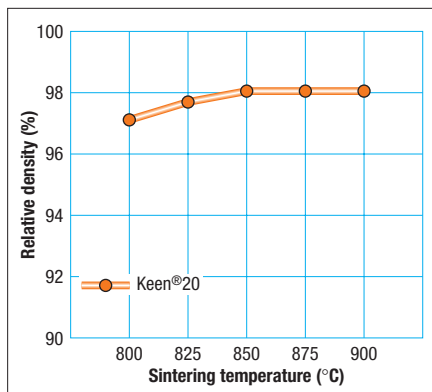


Fig 3a Variation of relative density with sintering temperature for Keen20

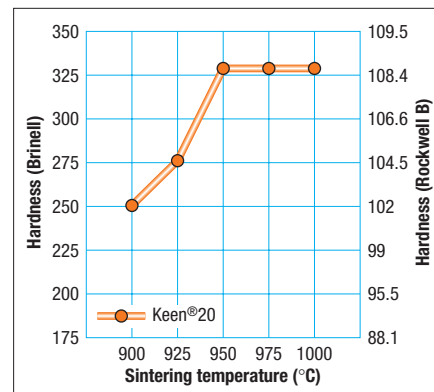


Fig 3b Variation of hardness with sintering temperature for Keen20

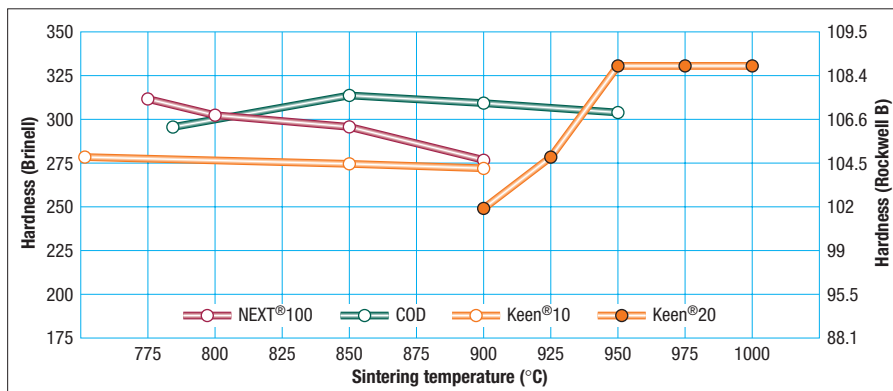


Fig 4 Comparison of variation of hardness with sintering temperature for different products

strength (or resilience) values and a 3-point bending test – which recorded the complete stress-strain curve – was used for calculating rupture deflection and rupture strength. The results for the two new keen products compared to other products are shown in Figs 5 and 6.

Fig 5 shows the high values of impact strength for the Keen products which remain constant as the hardness increases, thus assuring the ductility of the bond that is required for the targeted applications. Fig 6 demonstrates the exceptional mechanical strength of the Keen products as shown by the constant rupture strength/rupture deflection plot. This leads to the manufacture of segments which are less brittle which is also a desirable property for the intended application areas.

Additives

Both Keen10 and Keen20 can easily be mixed with traditional additives such as copper, bronze and tungsten carbide. Pre-mixed batches with any type of additive will be readily supplied by eurotungstene. This can be for both technical or economical purposes.

Figs 7 and 8 show how the hardness and impact strength properties of Keen are affected by the addition of bronze and tungsten carbide. Customers have the option to include additives to either slightly increase or decrease these values to suit the particular cutting conditions to be encountered.

Summary

The development of the Keen range of prealloyed metal powders is part of an ongoing process by the suppliers of powders to the diamond toolmaking industry to provide high performance bonds at ever lower costs.

In particular, prealloyed powders provide a technological answer for applications where cobalt is still needed and the launch of additional products such as this will further increase the prealloyed market share.

Both Keen products discussed here exhibit great mechanical strength combined with high ductility, properties which make them ideal for certain applications. Keen10 is a cost effective product which gives segments with a free cutting action and a good tool life. Keen20, on the other hand is a more high-tech product which

has exceptional mechanical properties making it suitable for segments used in the more extreme applications.

Both products allow for easy mixing with traditional additives and are protected against oxidation. ♦

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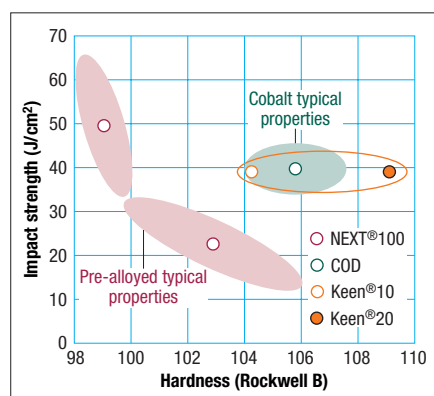


Fig 5 Comparison of variation of impact strength with hardness for different products

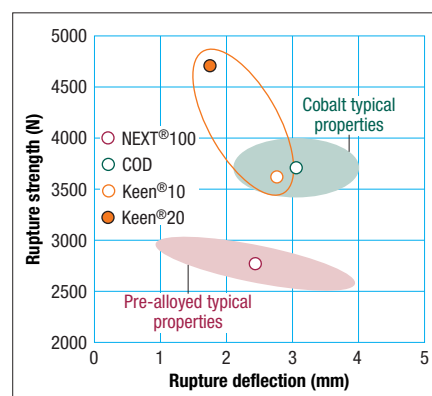


Fig 6 Comparison of variation of rupture strength with hardness for different products

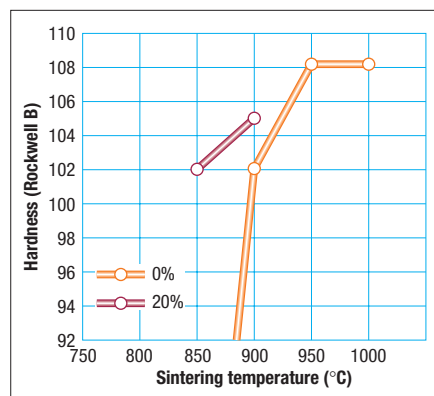


Fig 7a Effect of bronze additive on hardness of Keen20

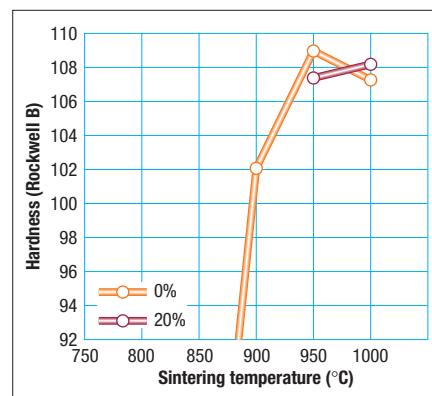


Fig 7b Effect of WC additive on hardness of Keen20

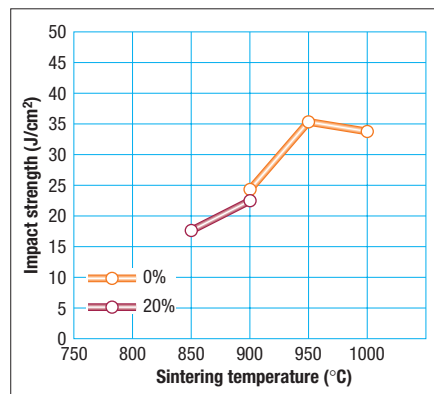


Fig 8a Effect of bronze additive on impact strength of Keen20

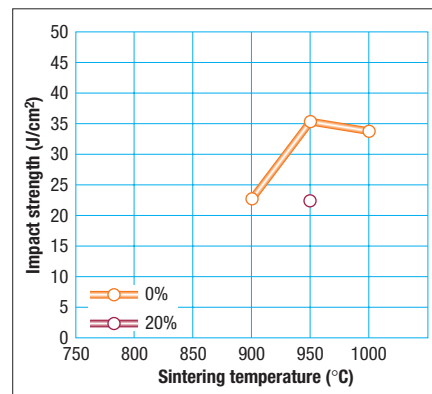


Fig 8b Effect of WC additive on impact strength of Keen20