Map of diamond-boron bond paves way for new materials

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Scientists in Japan have successfully recorded the atomic bonds between diamond and cubic boron nitride: the hardest known materials on earth. This feat could ultimately lead to the design of new types of semiconductors.

Diamond is the hardest material in existence but is useless for cutting steel because it reacts with iron, from which steel is made, at high temperatures. Cubic boron nitride, a synthetic material, is the second hardest substance after diamond but is chemically stable against iron at high temperatures. If desirable composites of diamond and cubic boron nitride crystals could be obtained, a unique machining tool could be developed for work on hard rock and substances that contain iron. Also, a better understanding of the bonds formed between these two unique semiconducting materials could lead to the development of new types of semiconductors. The nature of these bonds was previously unknown.

Reporting their findings in *Nature Communications*, a team of researchers at Tohoku University, the National Institute for Materials Science and the Japan Fine Ceramics Center imaged bonded diamond and boron nitride, both crystalline materials, using a super-high-resolution scanning electron microscope. The team then subjected those observations to extensive theoretical calculations.

When the researchers analysed the atomic bonds, they found that the connections between the two materials had a regularly patterned atomic structure. Strangely enough, it was only by tracking pattern irregularities – certain types of crystal lattice defects formed in the boundary layer between the two materials – that the researchers were able to calculate the main pattern.

The team is conducting research to further understand the nature of the diamond/cubic boron nitride bond. They aim to be able to control the way lattice defects form in crystal layers between diamond and boron nitride. This would ultimately propel the research and development of novel functional materials with unique properties.

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