The detection of nickel in synthetic diamond

An application using Oxford Instruments ED2000 EDXRF spectrophotometer and **Microstat**N cryostat

The Certificates Department of the Diamond High Council in Antwerp, Belgium, only issues certificates for polished, natural gem diamonds. The detection of synthetic diamonds is hence crucial.

In nature, diamond growth requires high pressure and high temperature. In the fifties scientists were, for the first time, able to imitate these growth conditions using large presses. These days an alloy of iron-nickel, which serves as a solvent-catalyst for diamond growth, is often used. The nickel is included in the diamond as atomic as well as micrometer-sized impurity. Both types of impurities can be detected by the Oxford Instruments ED2000 EDXRF spectrophotometer (see figure 1). As a substitutional atomic impurity, nickel has an easily detectable line in the photoluminescence spectrum. Strong quenching of the luminescence makes the spectrum not easy to detect at room temperature, but the signal is very strong at 77 K.

When a section of a synthetic diamond grown in a Bars press is made, yellow, colourless and brown zones (see figure 2) can be observed. This colour variation corresponds to different impurity concentrations in different crystallographic growth sectors. The yellow colour is related to single substitutional nitrogen defects in the diamond lattice, while it is suspected that the nickel causes the brown colour[1].

Luminescence is excited by a 514.5 nm Argon-ion laser and detected by a Renishaw RM2000 system with Oxford Instruments **Microstat**N cryostat. The large optical window and long thermal stability are excellent for line scans on macroscopic samples. In the section of synthetic diamond, the intensity of the Zero Phonon Line at 493.9 nm of the nickel related luminescence is monitored in three different line scans and it appears that its intensity correlates with the brown colour (figure 3). The evidence is indirect, but the measurement supports the view that nickel causes the brown colour in the synthetic diamonds, grown from Fe-Ni catalyst-solvent.

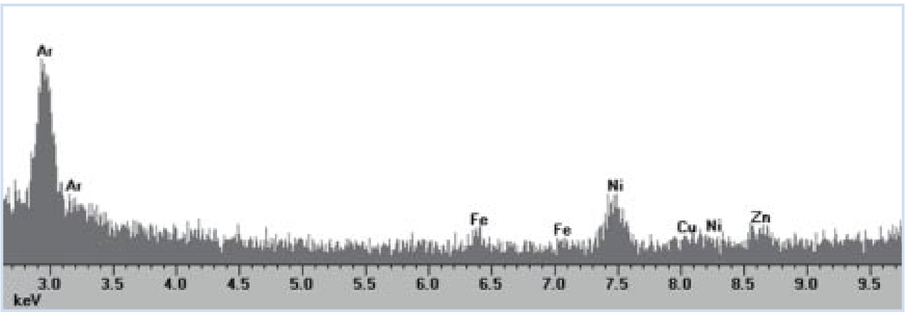

Figure 1: The EDXRF spectrum of the synthetic diamond. The spectrum indicates the presence of nickel (Ni) and iron (Fe) because the diamond was grown in a catalyst-solvent containing iron and nickel. The Argon line (Ar) is due to the argon in the air. The presence of copper (Cu) and zinc (Zn) is due to minute traces from brass clamps in which the diamond was set prior to the EDXRF measurement.

The Certificates Department of the Diamond High Council in Antwerp, Belgium, issues certificates for natural gem stones only. The Department distinguishes between natural and synthetic stones using spectrophotometry at 77 K, which detects nickel impurities from catalysts used in the production of synthetic gems.

Reference

[1] Lawson S.C., Kanda H., Sekita M., *Phil. Mag.* B, (68), 39-46 (1993)

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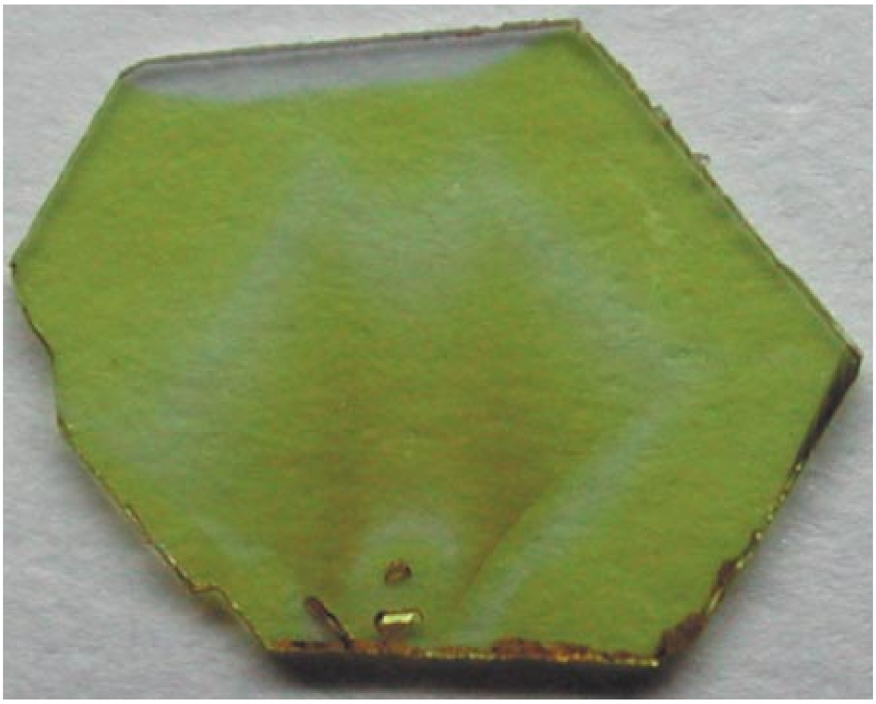

Figure 2: A section of a synthetic diamond. The zones with different colours are located in different growth sectors.

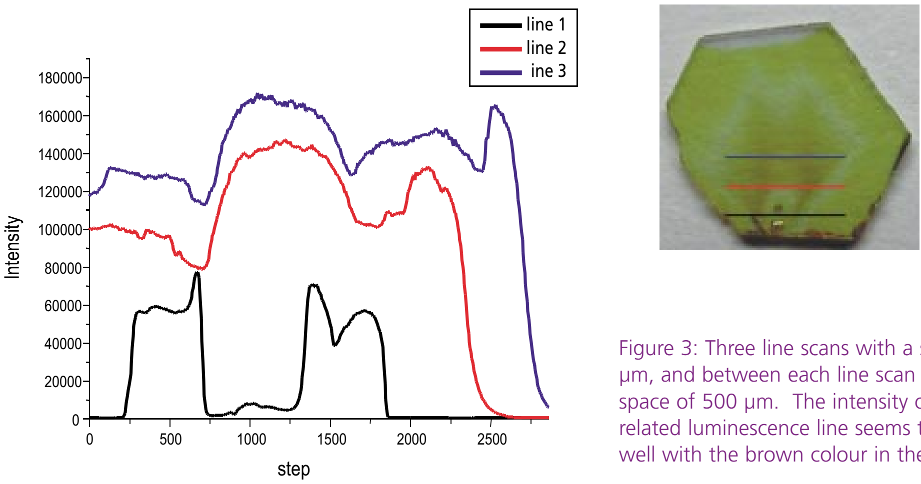

Figure 3: Three line scans with a stepsize of 5 µm, and between each line scan there is a space of 500 µm. The intensity of the nickel related luminescence line seems to correlate well with the brown colour in the diamond.

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