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Raman mapping of mechanical stress field in diamond around a chromite inclusion

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Raman mapping of a stressed chromite inclusion in diamond was carried out: x-y stress field of diamond around the chromite inclusion was created on the position of diamond Raman band (1332 cm–1 at 1 bar) at a constant depth z which coincides with the depth of inclusions in diamond (z$\sim$ 80*μm). Raman signal (spectrum in the range of 1100-1500 cm–1) for each point was accumulated with a spatial resolution of 5 μm.
Mechanical stresses in diamond can be caused by various reasons: syngenesis of the diamond-matrix and chromite inclusion at high P-T leads to stresses after cooling and removing the pressure; anisotropic compression of diamond in close proximity to native defects of growth, dislocations; effects of impurities and others. Consider the first reason as the main one for the occurrence of a stressed condition.
Stressed diamond field around the inclusion has radial and azimuthal components. The observed azimuthal dependence has a brighter contrast than the radial one. We assume that the strong azimuthal stresses are due to non-spherical inclusion, that initiates anisotropic stress at the vertices and to different compressibility of a diamond crystal along crystallographic directions [111] with Raman shift of 2.2 cm–1/GPa and 0.7 cm–1/GPa along [001] according to Grimsditch et al., (1978). These two directions in some projection can form an angle that differs from 90°, which could explain the azimuthal stress field. Additional complex stress is evoked by cracks in diamond. The internal pressure in chromite inclusion is estimated as $\sim$0.8 GPa.
Raman spectra of diamond taken near the stressed chromite inclusion indicate the stress state of diamond and the presence of graphite in a narrow surface region of the inclusion. Graphite is characterized by the 1st order Raman band at 1583 cm-1 and the 2nd order band at $\sim$2725 cm-1. All spectra exhibit a strong low frequency Raman band at 140 cm-1, whose origin is still unclear.
Raman mapping was carried out in the diamond field around the stressed chromite inclusion. This mapping revealed significant mechanical stresses in the diamond near the inclusions, which decrease with increasing distance from the inclusion. In addition to this radial dependence, we found a strong azimuthal dependency, indicating a strong stress on the edges and vertices of a polyhedron - the surface of the inclusion. The main reason that causes these stresses is a syngenesis of the diamond-matrix and chromite inclusion at high P-T, which leads to stresses after cooling and removal of pressure due to differences in coefficients of thermal expansion and compressibility of diamond and chromite.
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