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(54) Title: SINGLE CRYSTAL CVD SYNTHETIC DIAMOND MATERIAL

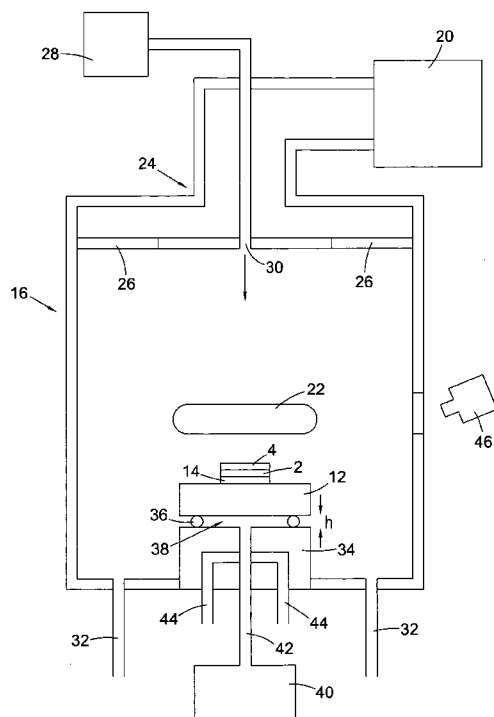


Fig. 3

(57) Abstract: A single crystal CVD synthetic diamond material comprising: a total as-grown nitrogen concentration equal to or greater than 5 ppm, and a uniform distribution of defects, wherein said uniform distribution of defects is defined by one or more of the following characteristics: (i) the total nitrogen concentration, when mapped by secondary ion mass spectrometry (SIMS) over an area equal to or greater than 50 x 50 μm using an analysis area of 10 μm or less, possesses a point-to-point variation of less than 30% of an average total nitrogen concentration value, or when mapped by SIMS over an area equal to or greater than 200 x 200 μm using an analysis area of 60 μm or less, possesses a point-to-point variation of less than 30% of an average total nitrogen concentration value; (ii) an as-grown nitrogen-vacancy defect (NV) concentration equal to or greater than 50 ppb as measured using 77K UV-visible absorption measurements, wherein the nitrogen-vacancy defects are uniformly distributed through the synthetic single crystal CVD diamond material such that, when excited using a 514 nm laser excitation source of spot size equal to or less than 10 μm at room temperature using a 50 mW continuous wave laser, and mapped over an area equal to or greater than 50 x 50 μm with a data interval less than 10 μm , there is a low point-to-point variation wherein the intensity area ratio of nitrogen vacancy photoluminescence peaks between regions of high photoluminescent intensity and regions of low photoluminescent intensity is $<2\times$ for either the 575 nm photoluminescent peak (NV⁰) or the 637 nm photoluminescent peak (NV); (iii) a variation in Raman intensity such that, when excited using a 514 nm laser excitation source (resulting in a Raman peak at 552.4 nm) of spot size equal to or less than 10 μm at room temperature using a 50 mW continuous wave laser, and mapped over an area equal to or greater than 50 x 50 μm with a data interval less than 10 μm , there is a low point-to-point variation wherein the ratio of Raman peak areas between regions of low Raman intensity and high Raman intensity is $<1.25\times$; (iv) an as-grown nitrogen-vacancy defect (NV) concentration equal to or greater than 50 ppb as measured using 77K UV-visible absorption measurements, wherein, when excited using a 514 nm excitation

source of spot size equal to or less than 10 μm at 77K using a 50 mW continuous wave laser, gives an intensity at 575 nm corresponding to NV⁰ greater than 120 times a Raman intensity

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at 552.4 nm, and/or an intensity at 637 nm corresponding to NV^- greater than 200 times the Raman intensity at 552.4 nm; (v) a single substitutional nitrogen defect (N_s) concentration equal to or greater than 5 ppm, wherein the single substitutional nitrogen defects are uniformly distributed through the synthetic single crystal CVD diamond material such that by using a 1344 cm^{-1} infrared absorption feature and sampling an area greater than an area of 0.5 mm^2 , the variation is lower than 80%, as deduced by dividing the standard deviation by the mean value; (vi) a variation in red luminescence intensity, as defined by a standard deviation divided by a mean value, is less than 15%; (vii) a mean standard deviation in neutral single substitutional nitrogen concentration of less than 80%; and (viii) a colour intensity as measured using a histogram from a microscopy image with a mean gray value of greater than 50, wherein the colour intensity is uniform through the single crystal CVD synthetic diamond material such that the variation in gray colour, as characterised by the gray value standard deviation divided by the gray value mean, is less than 40%.