Patent claims

1. Method for spatially resolved localisation of a defect in a material (18) that has a band gap, wherein the defect has one or more electrons (24) that have at least one energy level that lies in the band gap, wherein the electron (24) is excited such that it is emitted from the material and subsequently electron imaging (14) is carried out, wherein the electron imaging is carried out with the aid of electron optics (26, 28, 30, 32) and an electron detector (34), characterised in that the structure of a transmission electron microscope is used, wherein the material is arranged in place of an electron filament of the transmission electron microscope, wherein the defect is imaged with a spatial resolution of at least 25 nm.

2. Method according to claim 1, characterised in that the material (18) is a solid body, wherein the solid body is preferably in the form of a layer or bulk material and comprises, in particular, a substance from the group comprising diamond, silicon, silicon carbide, hexagonal boron nitride and crystalline materials with a band gap in the range of 0.1 eV to 14 eV , wherein the layer is preferably an atomically thin layer in a sub-nanometre range or a crystalline two-dimensional layer and/or in that the defect is imaged with a spatial resolution of at least 20 nm and in particular in the range of 0.1 nm to 20 nm.

3. Method according to claim 1 or 2, characterised in that a microchannel plate, a direct electron detector, an electron multiplier CCD, an sCMOS or a phosphor screen is used as the electron detector and/or in that a magnetic element or electromagnetic element is used as the electron optics (26, 28, 30, 32).

4. Method according to any one of the preceding claims, characterised in that the excitation of the electron (24) is effected by one or more electromagnetic waves, preferably light (16).

5. Method according to claim 4, characterised in that the excitation is focused on a region, preferably a surface region (20) of the material (18), wherein in particular light (16) is used that is focused by one or more optical elements, preferably an objective lens with a high numerical aperture, and/or

in that the excitation is effected by a LASER light source and/or

in that the excitation is effected in evanescent wave geometry and/or

in that the defect is arranged in a light-confining nanostructure, cavity or optical resonator.

6. Method according to any one of the preceding claims, characterised in that the spin state of the electron (24) is determined by one or more additional excitations with electromagnetic waves, preferably light, radio waves or microwaves, by electromagnetic fields, by thermal processes or by thermionic processes.

7. Method according to any one of the preceding claims, characterised in that the material (18) is electrically earthed (23).

8. Method according to any one of the preceding claims, characterised in that a bias voltage (26) is applied above the surface (22) of the material (18), wherein the bias voltage is preferably positive, wherein the bias voltage is applied in particular to an electrode, preferably a grid (26) or a tip.

9. Method according to any one of the preceding claims, characterised in that the material (18) is doped, preferably doped with a donor, preferably boron.

10. Method according to any one of the preceding claims, characterised in that the defect was created by at least one of the processes selected from the group comprising implantation after production of the material, doping during production of the material, or electron irradiation during or after production of the material.

11. Method according to any one of the preceding claims, characterised in that the surface of the material has been provided with a thin conductive layer, wherein the layer is preferably a metallic layer or a metal-coordinated molecular layer, wherein the layer consists in particular of one or two to five monolayers.

12. Method according to any one of the preceding claims, characterised
in that the material is surrounded by a magnetic shielding and/or
in that the material is surrounded by a Faraday cage and/or
in that the material is placed in a vacuum with a pressure of no more than 10^3 mbar.

13. Method according to any one of the preceding claims, characterised in that the material is cooled, wherein the cooling is preferably carried out in the temperature range of 0.1 °K to 210 °K.

14. Device (10) for spatially resolved localization of a defect in a material (18), wherein the material (18) has a band gap, wherein the defect has one or more electrons (24) that has at least one energy level that lies in the band gap, wherein the device (10) has means (12) for exciting the electron (24) that are configured to excite the electron (24) such that it is emitted from the material (18), and has means (14) for electron imaging using electron optics (26, 28, 30, 32) and an electron detector (34), wherein the device comprises the structure of a transmission electron microscope, characterised in that the device (10) is configured such that the material is arranged in place of an electron filament of the transmission electron microscope, wherein the device (10) is configured such that the defect is imaged with a spatial resolution of at least 25 nm.

15. Device according to claim 14, characterised

in that the device (10) is configured to carry out the method according to any one of claims 2 to 13 and/or

in that the device is a component of a quantum computer or a quantum sensor.

16. Use of the method according to any one of claims 1 to 13 or the device according to any one of claim 14 or 15, characterised in that quantum computing applications, quantum-based information processing or quantum sensing applications are carried out therewith.