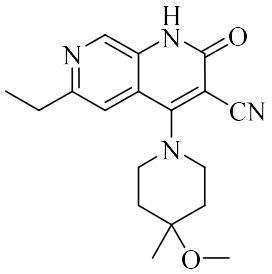
Claims

1. A crystal form I of a compound as shown in formula (I), 6-ethyl-4-(4-methoxy-4-methylpiperidin-1-yl)-2-oxo-1,2-dihydro-1,7-diazanaphthalene-3-carbonitrile, wherein the crystal form has an X-ray powder diffraction pattern comprising characteristic peaks at 7.3 ± 0.2°, 13.6 ± 0.2°, 14.5 ± 0.2°, 18.0 ± 0.2°, 19.1 ± 0.2°, 22.0 ± 0.2° and 23.4 ± 0.2° 2θ, by using Cu-Kα radiation,



(I).

2. The crystal form I according to claim 1, wherein the X-ray powder diffraction pattern further comprises characteristic peaks at 14.2 ± 0.2°, 16.1 ± 0.2°, 19.4 ± 0.2° and 25.6 ± 0.2° 2θ, by using Cu-Kα radiation.

3. The crystal form I according to claim 2, wherein the crystal form exhibits an X-ray powder diffraction pattern as substantially depicted in Figure 1 when Cu-Kα radiation is used.

4. A method for preparing the crystal form I according to claim 1,

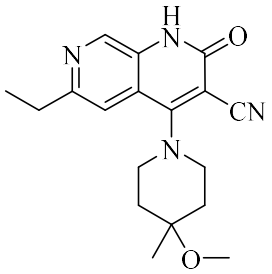
wherein the method comprises dissolving the compound of formula (I) in a single or mixed solvent, raising the temperature to reflux until complete dissolution, and slowly decreasing the temperature until the crystal form I is precipitated;

or completely dissolving the compound of formula (I) in a single or mixed solvent, and volatilizing the single or mixed solvent until the system is saturated and the crystal form I is precipitated;

the single or mixed solvent is selected from: one of or a mixture of methanol, ethanol, isopropanol, toluene, acetone, tetrahydrofuran, dichloromethane,

dichloroethane, ethyl acetate, acetonitrile, methyl tert-butyl ether, 2-methyltetrahydrofuran, dimethyl sulfoxide and water; preferably, the single or mixed solvent is selected from: methanol, ethanol, isopropanol, toluene, acetone, tetrahydrofuran, water\ethanol, water\isopropanol, dichloromethane, ethyl acetate, acetonitrile, dichloromethane\acetone, dichloromethane\acetonitrile, dichloromethane\ethyl acetate, dichloromethane\methyl tert-butyl ether, dichloromethane\tetrahydrofuran, dichloromethane\ethanol, dichloromethane\isopropanol, dichloromethane\toluene, dichloromethane\water\ethanol, and dichloromethane\water\isopropanol.

5. A crystal form II of a hydrochloride of a compound as shown in formula (I), 6-ethyl-4-(4-methoxy-4-methylpiperidin-1-yl)-2-oxo-1,2-dihydro-1,7-diazanaphthalene-3-carbonitrile, wherein the crystal form has an X-ray powder diffraction pattern comprising characteristic peaks at 4.0 ± 0.2°, 6.7 ± 0.2°, 7.9 ± 0.2°, 13.5 ± 0.2°, 14.2 ± 0.2°, 15.4 ± 0.2°, 20.2 ± 0.2° and 22.0 ± 0.2° 2θ, by using Cu-Kα radiation,



(I).

6. The crystal form II according to claim 5, wherein the X-ray powder diffraction pattern further comprises characteristic peaks at 10.2 ± 0.2°, 13.8 ± 0.2°, 14.6 ± 0.2°, 26.40 ± 0.2° and 26.80 ± 0.2° 2θ, by using Cu-Kα radiation.

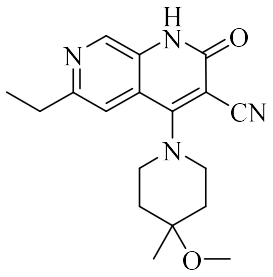
7. The crystal form II according to claim 6, wherein the crystal form exhibits an X-ray powder diffraction pattern as substantially depicted in Figure 6 when Cu-Kα radiation is used.

8. A method for preparing the crystal form II according to claim 5,

wherein the method comprises adding a single or mixed solvent to the hydrochloric acid of the compound of formula (I), heating the mixture until complete dissolution, and slowly cooling down the heated mixture until the crystal form II is precipitated;

the single or mixed solvent is selected from: one of or a mixture of methanol, ethanol, isopropanol and water; preferably, the single or mixed solvent is selected from methanol, ethanol, isopropanol, water\methanol, water\ethanol, and water\isopropanol.

9. A crystal form III of a hydrochloride of a compound as shown in formula (I),
6-ethyl-4-(4-methoxy-4-methylpiperidin-1-yl)-2-oxo-1,2-dihydro-1,7-diazanaphthalene-3-carbonitrile, wherein the crystal form has an X-ray powder diffraction pattern comprising characteristic peaks at 5.2 ± 0.2°, 6.4 ± 0.2°, 15.3 ± 0.2°, 18.6 ± 0.2°, 22.0 ± 0.2° and 26.4 ± 0.2° 2θ, by using Cu-Kα radiation,



(I).

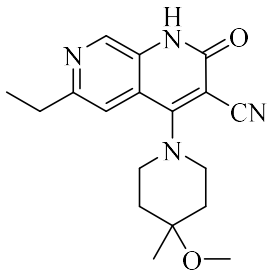
10. The crystal form III according to claim 9, wherein the X-ray powder diffraction pattern further comprises characteristic peaks at 8.0 ± 0.2°, 10.3 ± 0.2°, 13.5 ± 0.2° and 25.0 ± 0.2° 2θ, by using Cu-Kα radiation.

11. The crystal form III according to claim 10, wherein the crystal form exhibits an X-ray powder diffraction pattern as substantially depicted in Figure 9 when Cu-Kα radiation is used.

12. A method for preparing the crystal form III according to claim 11,

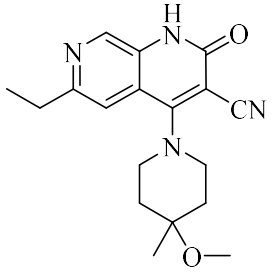
wherein the method comprises adding a single or mixed solvent to the hydrochloric acid of the compound of formula (I), heating the mixture until complete dissolution, immediately performing filtration, and concentrating the filtrate until the crystal form III is precipitated; the single or mixed solvent is selected from: one of or a mixture of acetonitrile, acetone, tetrahydrofuran and ethyl acetate.

13. A crystal form IV of a p-toluenesulfonate of a compound as shown in formula (I), 6-ethyl-4-(4-methoxy-4-methylpiperidin-1-yl)-2-oxo-1,2-dihydro-1,7-diazanaphthalene-3-carbonitrile, wherein the crystal form has an X-ray powder diffraction pattern comprising characteristic peaks at 5.8 ± 0.2°, 7.8 ± 0.2°, 9.3 ± 0.2°, 11.3 ± 0.2°, 13.7 ± 0.2°, 14.8 ± 0.2° and 15.7 ± 0.2° 2θ, and further comprising characteristic peaks at 17.1 ± 0.2°, 18.7 ± 0.2°, 20.0 ± 0.2° and 22.4 ± 0.2° 2θ, by using Cu-Kα radiation,



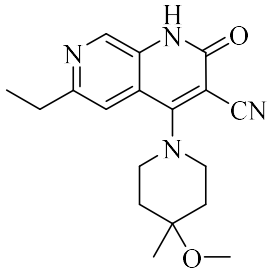
(I).

14. A crystal form V of a methanesulfonate of a compound as shown in formula (I), 6-ethyl-4-(4-methoxy-4-methylpiperidin-1-yl)-2-oxo-1,2-dihydro-1,7-diazanaphthalene-3-carbonitrile, wherein the crystal form has an X-ray powder diffraction pattern comprising characteristic peaks at 7.0 ± 0.2°, 9.7 ± 0.2°, 13.2 ± 0.2°, 18.1 ± 0.2°, 19.5 ± 0.2°, 20.7 ± 0.2° and 21.7 ± 0.2° 2θ, and further comprising characteristic peaks at 16.9 ± 0.2°, 18.6 ± 0.2°, 19.1 ± 0.2°, 20.2 ± 0.2° and 28.0 ± 0.2° 2θ, by using Cu-Kα radiation,



(I).

15. A crystal form VI of a sulfate of a compound as shown in formula (I), 6-ethyl-4-(4-methoxy-4-methylpiperidin-1-yl)-2-oxo-1,2-dihydro-1,7-diazanaphthalene-3-carbonitrile, wherein the crystal form has an X-ray powder diffraction pattern comprising characteristic peaks at 4.4 ± 0.2°, 7.1 ± 0.2°, 8.8 ± 0.2°, 14.3 ± 0.2°, 17.8 ± 0.2°, 19.6 ± 0.2° and 21.6 ± 0.2° 2θ, and further comprising characteristic peaks at 25.5 ± 0.2° and 27.7 ± 0.2° 2θ, by using Cu-Kα radiation,



(I).

16. A pharmaceutical composition comprising the crystal form I according to any one of claims 1-3, the crystal form II according to any one of claims 5-7, the crystal form III according to any one of claims 9-11, the crystal form IV according to claim 13, the crystal form V according to claim 14, or the crystal form VI according to claim 15, and one or more second therapeutically active agents.

17. A pharmaceutical preparation comprising the crystal form I according to any one of claims 1-3, the crystal form II according to any one of claims 5-7, the crystal form III according to any one of claims 9-11, the crystal form IV according to claim 13, the crystal form V according to claim 14, or the crystal form VI according to claim 15, and one or more pharmaceutical carriers.

18. Use of the crystal form I according to any one of claims 1-3, the crystal form II according to any one of claims 5-7, the crystal form III according to any one of claims 9-11, the crystal form IV according to claim 13, the crystal form V according to claim 14, or the crystal form VI according to claim 15, , the pharmaceutical composition according to claim 17 or the pharmaceutical preparation according to claim 18 in the manufacture of a medicament for treating or preventing PDE9-mediated related diseases; wherein the PDE9-mediated related diseases is selected from CNS impairments associated with perception, attention, memory and learning, senile dementia, schizophrenia, age-related memory loss, vascular dementia, craniocerebral injury, stroke, post-stroke dementia, post-traumatic dementia, general attention deficit, attention deficit with learning and memory problems in children, Alzheimer's disease, Lewy body dementia, frontotemporal lobe degeneration dementia, cortical basal ganglionic degeneration dementia, amyotrophic lateral sclerosis disease, Huntington's disease, multiple sclerosis, thalamic degeneration, dementia in Creutzfeldt-Jakob disease, HIV dementia, schizophrenia, epilepsy, Korsakoff's psychosis, depression, bipolar affective disorder, sleep disorder, metabolic syndrome, obesity, diabetes, hyperglycemia, dyslipidemia, impaired glucose tolerance, heart failure, anemia, sickle-cell disease.