CLAIMS

[Claim 1] A type II crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide,

wherein the crystal has peaks in a powder X-ray diffraction spectrum at diffraction angles (2θ ± 0.2°) of:

(i) one or more selected from the group consisting of 15.6°, 20.1°, 24.7°, and 28.9°; and

(ii) two or more selected from the group consisting of 7.8°, 10.6°, 14.0°, 14.8°, 17.2°, 21.6°, 22.2°, and 25.8°.

[Claim 2] The crystal according to claim 1, wherein the crystal has peaks in a powder X-ray diffraction spectrum at a total of five or more diffraction angles (2θ ± 0.2°) selected from groups (i) and (ii) above.

[Claim 3] The crystal according to claim 1 or 2, wherein the crystal has peaks in a powder X-ray diffraction spectrum at a total of seven or more diffraction angles (2θ ± 0.2°) selected from groups (i) and (ii) above.

[Claim 4] The crystal according to any one of claims 1 to 3, wherein the crystal has a powder X-ray diffraction spectrum substantially identical to the powder X-ray diffraction spectrum shown in Figure 3.

[Claim 5] The crystal according to any one of claims 1 to 4, wherein an exothermic peak determined by simultaneous thermogravimetric-differential thermal analysis is around 236°C.

[Claim 6] The crystal according to any one of claims 1 to 5, wherein the crystal has a crystal purity of 95% by weight or more.

[Claim 7] The crystal according to any one of claims 1 to 6, wherein the crystal has a chemical purity of 95% or more.

[Claim 8] A method for producing the type II crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide according to any one of claims 1 to 7, the method comprising stirring N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide in a single solvent of a lower alcohol with 3 or more carbon atoms, tetrahydrofuran, acetone, or ethyl acetate, or in a mixed solvent comprising two or more of these solvents.

[Claim 9] A type III crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide with succinic acid, wherein the crystal has peaks in a powder X-ray diffraction spectrum at three or more diffraction angles (2θ ± 0.2°) selected from the group consisting of 10.4°, 13.3°, 14.6°, 15.7°, 17.2°, 18.3°, 19.7°, 20.8°, 22.3°, and 27.5°.

[Claim 10] The crystal according to claim 9, wherein the crystal has peaks in a powder X-ray diffraction spectrum at five or more diffraction angles (2θ ± 0.2°) selected from the group consisting of 10.4°, 13.3°, 14.6°, 15.7°, 17.2°, 18.3°, 19.7°, 20.8°, 22.3°, and 27.5°.

[Claim 11] The crystal according to claim 9 or 10, wherein the crystal has peaks in a powder X-ray diffraction spectrum at seven or more diffraction angles (2θ ± 0.2°) selected from the group consisting of 10.4°, 13.3°, 14.6°, 15.7°, 17.2°, 18.3°, 19.7°, 20.8°, 22.3°, and 27.5°.

[Claim 12] The crystal according to any one of claims 9 to 11, wherein the crystal has a powder X-ray diffraction spectrum substantially identical to the powder X-ray diffraction spectrum shown in Figure 13.

[Claim 13] The crystal according to any one of claims 9 to 12, wherein an endothermic peak determined by simultaneous thermogravimetric-differential thermal analysis is around 202°C.

[Claim 14] The crystal according to any one of claims 9 to 13, wherein the crystal has a crystal purity of 95% by weight or more.

[Claim 15] The crystal according to any one of claims 9 to 14, wherein the crystal has a chemical purity of 95% or more.

[Claim 16] A method for producing the type III crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide with succinic acid according to any one of claims 9 to 15, the method comprising stirring N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide and succinic acid at an equivalent ratio of 1:1-10 in a single solvent selected from acetonitrile, a lower alcohol with 2 or more carbon atoms, methyl ethyl ketone, tetrahydrofuran, or 2-methyltetrahydrofuran, or in a mixed solvent comprising two or more of these solvents.

[Claim 17] A type I crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide with sorbic acid, wherein the crystal has peaks in a powder X-ray diffraction spectrum at three or more diffraction angles (2θ ± 0.2°) selected from the group consisting of 12.6°, 14.7°, 15.4°, 15.9°, 17.1°, 18.9°, 22.2°, 24.1°, 25.8°, and 27.4°.

[Claim 18] The crystal according to claim 17, wherein the crystal has peaks in a powder X-ray diffraction spectrum at five or more diffraction angles (2θ ± 0.2°) selected from the group consisting of 12.6°, 14.7°, 15.4°, 15.9°, 17.1°, 18.9°, 22.2°, 24.1°, 25.8°, and 27.4°.

[Claim 19] The crystal according to claim 17 or 18, wherein the crystal has peaks in a powder X-ray diffraction spectrum at seven or more diffraction angles (2θ ± 0.2°) selected from the group consisting of 12.6°, 14.7°, 15.4°, 15.9°, 17.1°, 18.9°, 22.2°, 24.1°, 25.8°, and 27.4°.

[Claim 20] The crystal according to any one of claims 17 to 19, wherein the crystal has a powder X-ray diffraction spectrum substantially identical to the powder X-ray diffraction spectrum shown in Figure 15.

[Claim 21] The crystal according to any one of claims 17 to 20, wherein an endothermic peak determined by simultaneous thermogravimetric-differential thermal analysis is around 173°C.

[Claim 22] The crystal according to any one of claims 17 to 21, wherein the crystal has a crystal purity of 95% by weight or more.

[Claim 23] The crystal according to any one of claims 17 to 22, wherein the crystal has a chemical purity of 95% or more.

[Claim 24] A method for producing the type I crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide with sorbic acid according to any one of claims 17 to 23, the method comprising stirring N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide and sorbic acid at an equivalent ratio of 1:1-10 in a single solvent selected from acetonitrile, a lower alcohol, tetrahydrofuran, acetone, methyl ethyl ketone, water, or ethyl acetate, or in a mixed solvent comprising two or more of these solvents.

[Claim 25] A type III crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide, wherein the crystal has peaks in a powder X-ray diffraction spectrum at diffraction angles (2θ ± 0.2°) of:

(i) one or more selected from the group consisting of 8.8°, 11.6°, and 17.9°; and

(ii) two or more selected from the group consisting of 6.6°, 12.3°, 13.8°, 18.6°, 21.3°, and 22.3°.

[Claim 26] The crystal according to claim 25, wherein the crystal has peaks in a powder X-ray diffraction spectrum at a total of five or more diffraction angles (2θ ± 0.2°) selected from groups (i) and (ii) above.

[Claim 27] The crystal according to claim 25 or 26, wherein the crystal has peaks in a powder X-ray diffraction spectrum at a total of seven or more diffraction angles (2θ ± 0.2°) selected from groups (i) and (ii) above.

[Claim 28] The crystal according to any one of claims 25 to 27, wherein the crystal has a powder X-ray diffraction spectrum substantially identical to the powder X-ray diffraction spectrum shown in Figure 1.

[Claim 29] The crystal according to any one of claims 25 to 28, wherein an exothermic peak determined by simultaneous thermogravimetric-differential thermal analysis is around 228°C.

[Claim 30] The crystal according to any one of claims 25 to 29, wherein the crystal has a crystal purity of 95% by weight or more.

[Claim 31] The crystal according to any one of claims 25 to 30, wherein the crystal has a chemical purity of 95% or more.

[Claim 32] A method for producing the type III crystal of N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide according to any one of claims 25 to 31, the method comprising stirring N-(4-(4-amino-6-ethynyl-5-(quinolin-3-yl)-7H-pyrrolo[2,3-d]pyrimidin-7-yl)bicyclo[2.2.1]heptan-1-yl)-5-methylpyrazine-2-carboxamide in a methanol-containing solvent.

[Claim 33] A pharmaceutical composition comprising the crystal according to any one of claims 1 to 7, 9 to 15, 17 to 23, and 25 to 31.