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(54) Title: CRYSTAL FORMS OF 5- [3- (2, 5-DICHLORO-4, 6-DIMETHYL-1-OXY-PYRIDINE-3-YL) [1,2,3] OXADIAZOL-5-YL] -3-NIT ROBENZENE-1, 2-DIOL

(57) Abstract: This invention relates to novel polymorphs of (HO)₂NO₂(C₆H)-(C₂N₂O)-(C₅N)(CH₃)₂Cl₂O, to processes for their preparation, and to pharmaceutical compositions containing said novel polymorphs as active pharmaceutical ingredient.



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CRYSTAL FORMS OF

5- [3- (2, 5-DICHLORO-4, 6-DIMETHYL-1-OXY-PYRIDINE-3-YL) [1, 2, 3] OXADIAZOL-5-YL] -3-NITROBENZENE-1, 2-DIOL

This invention relates to novel polymorphs of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol, an inhibitor of catechol-*O*-methyltransferase (COMT), to processes for their preparation, and to pharmaceutical compositions containing said novel polymorphs as active pharmaceutical ingredient.

Despite being used in clinical practice for several decades, levodopa (L-DOPA) continues to be the gold standard drug for the symptomatic treatment of Parkinson's disease. This has helped to maintain keen interest in the development of inhibitors of the enzyme catechol-*O*-methyltransferase (COMT) based on the hypothesis that inhibition of this enzyme may provide clinical improvements in patients afflicted by diseases such as Parkinson's disease and undergoing treatment with L-DOPA and a peripheral amino acid decarboxylase (AADC) inhibitor.

The rationale for the use of COMT inhibitors as adjuncts to L-DOPA/AADC therapy is based on their ability to reduce metabolic *O*-methylation of L-DOPA to 3-*O*-methyl-L-DOPA (3-OMD). The duration of L-DOPA induced clinical improvement is brief as a result of the short *in vivo* half-life of L-DOPA which contrasts with the long half-life of 3-OMD. Additionally, 3-OMD competes with L-DOPA for transport across the blood-brain barrier (BBB), which means that only a very limited amount of an orally administered dose of L-DOPA actually reaches the site of action, i.e. the brain. Commonly, within only a few years of starting L-DOPA therapy with the usual dosage regime, L-DOPA induced clinical improvement declines at the end of each dose cycle, giving rise to the so-called 'wearing-off' pattern of motor fluctuations. A close relationship between the 'wearing-off' phenomenon and accumulation of 3-OMD has been described (Tohgi, H., et al., Neurosci. Letters, 132:19-22, 1992). It has been speculated that this may result from impaired brain penetration of L-DOPA due to competition for the transport system across the BBB with 3-OMD (Reches, A. et al., Neurology, 32:887-888, 1982) or more simply that there is less L-DOPA available to reach the brain (Nutt, J.G., Fellman, J.H., Clin. Neuropharmacol., 7:35-49, 1984). In effect, COMT inhibition protects L-DOPA from metabolic breakdown in the periphery through *O*-methylation, such that with repeated

doses of L-DOPA, the mean plasma L-DOPA concentration is raised. In addition to reduced competition for transport into the brain, a significantly greater percentage of the orally administered dose of L-DOPA is able to reach the site of action. Thus, COMT inhibition serves to increase the bioavailability of L-DOPA and therefore the duration of antiparkinsonian action is prolonged with single doses of L-DOPA (Nutt, J.G., Lancet, 351:1221-1222, 1998).

5- $[3-(2,5\text{-dichloro-}4,6\text{-dimethyl-}1\text{-oxy-pyridin-}3\text{-yl})-[1,2,4]\text{oxadiazol-}5\text{-yl}]$ -3-nitrobenzene-1,2-diol is a COMT inhibitor exhibiting an exceptionally long duration of action as well as balanced properties of bioactivity, bioavailability and safety. It markedly enhances the bioavailability of L-DOPA, increases the delivery of L-DOPA to the brain and significantly augments the levels of dopamine in the brain over extended periods of time.

As such, 5- $[3-(2,5\text{-dichloro-}4,6\text{-dimethyl-}1\text{-oxy-pyridin-}3\text{-yl})-[1,2,4]\text{oxadiazol-}5\text{-yl}]$ -3-nitrobenzene-1,2-diol is a promising candidate for treating a subject afflicted by a central or peripheral nervous system disorder, in particular for treating mood disorders, movement disorders such as Parkinson's disease and parkinsonian disorders and restless leg syndrome, gastrointestinal disturbances, oedema formation states and hypertension.

Methods of preparing 5- $[3-(2,5\text{-dichloro-}4,6\text{-dimethyl-}1\text{-oxy-pyridin-}3\text{-yl})-[1,2,4]\text{oxadiazol-}5\text{-yl}]$ -3-nitrobenzene-1,2-diol are described in WO2007/013830 A1.

The ability of a substance, for example 5- $[3-(2,5\text{-dichloro-}4,6\text{-dimethyl-}1\text{-oxy-pyridin-}3\text{-yl})-[1,2,4]\text{oxadiazol-}5\text{-yl}]$ -3-nitrobenzene-1,2-diol, to exist in more than one crystalline form is defined as polymorphism and these different crystalline forms may be referred to as "polymorphic modifications" or "polymorphs". For the purposes of this specification, the term 'polymorph' may also encompass pseudo-polymorphs. In general, polymorphism is caused by the ability of the molecule of a substance to change its conformation or to form different intermolecular and intramolecular interactions, particularly hydrogen bonds, resulting in different atomic arrangements in the crystal lattices of the different polymorphs. The polymorphs of a substance possess different crystal lattice energies and, thus, also exhibit different solid state physical properties such as morphology, density,

melting point, colour, stability, dissolution rate, milling facility, granulation properties, compacting properties etc.

There are a number of processes for characterizing polymorphs. State of the art technologies include X-ray-based technologies such as X-ray powder diffraction, single crystal X-ray diffraction, microscopy, differential scanning calorimetry, and spectroscopic methods such as IR, near-IR (NIR), Raman and solid state NMR.

In pharmaceutical compositions, the use of different polymorphs often influences factors such as the preparation of pharmaceutical compositions, their stability, dissolution properties, bioavailability and, consequently, their action. In other words, the use of polymorphs allows modulation of the performance of an active pharmaceutical ingredient (API) such as 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxa-diazol-5-yl]-3-nitrobenzene-1,2-diol as well as affecting the formulation of the API.

Accordingly, it is the object of the present invention to provide novel polymorphs of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol.

The present invention not only relates to the provision of novel polymorphs of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol (henceforth referred to as "compound of the invention"), but also to processes for their preparation, and to pharmaceutical compositions containing one or more of said novel polymorphs as active ingredient.

In one embodiment, the present invention relates to a polymorph of the compound of the invention which is, in the following specification, referred to as polymorph A. A process for the preparation of polymorph A is given in the experimental section. Polymorph A is a crystalline polymorph and, thus, characterizable by its powder X-ray diffraction pattern (XRPD). The diffraction pattern may either be experimentally recorded or calculated from the results of the measurement of the unit cell parameters of the polymorph. In the

following, characteristic peaks of the XRPDs of the polymorphs of the invention are given in degrees 2θ (Cu-K α radiation).

Polymorph A is characterizable by one or more of the peaks given in the following table.

5

table 1 – XRPD of polymorph A

Peak Position (°2θ)	Rel. Intensity (%)
6.6	55
6.9	9
11.8	40
13.2	100
17.2	8
17.9	33
19.8	25
22.6	12
23.2	71
23.8	74
24.3	36
25.3	53
25.9	42
26.4	45
27.8	11
28.2	36
28.6	29
29.6	16
29.9	20
30.3	11
30.7	14
32.0	5
32.7	14

33.5	6
34.1	6
35.1	9
36.5	9
37.0	8
37.6	4
39.2	5

Preferably, polymorph A is characterized by one or more of the above peaks in the range of from about 5 to about 25 °/2 θ which is a highly characteristic region of XRPDs. More preferably, polymorph A is characterized by 2 to 10, preferably 3 to 5, peaks within the
5 range of from about 5 to about 25 °/2 θ . Even more preferably, the polymorph A is characterized by the signals at 6.6, 13.2, 17.9, 23.2, 23.8 and 24.3 °/2 θ . Most preferably, polymorph A is characterized by the signals at 6.6, 13.2, 17.9 and 23.8 °/2 θ .

One skilled in the art will recognize that the 2 θ degrees given above will generally be
10 reproducible to within a range from about ± 0.10 2 θ degrees to about ± 0.20 2 θ degrees, with a preferred range being ± 0.10 2 θ degrees. See e.g. United States Pharmacopoeia XXV (2002), p. 2088-2089. This also applies to other XRPD data given in this specification.

In addition, polymorph A may also be characterizable by having an exotherm at 251 °C in a
15 Differential Scanning Calorimetry (DSC) thermogram.

One skilled in the art will recognize that the exotherm given above will generally be reproducible to within a range from about ± 0.5 to 3 °C, preferably ± 2 °C, more preferably ± 1 °C, and most preferably ± 0.5 °C. This also applies to other DSC and also the melt-onset
20 of hot stage data given in this specification.

Hotstage analysis also indicates that polymorph A may also be characterised by exhibiting a melt onset at 238 °C.

Furthermore, polymorph A may also be characterized by being non-hygroscopic over the range of about 5 % to about 95 %, more preferably from about 25 % to about 80 %, and even more preferably from about 40 % to about 60%, relative humidity at 25 °C over a period of 3 months.

5

In addition, polymorph A is preferably an anhydrate as is evidenced by a lack of solvent desorption in combined Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) experiments prior to energetic decomposition.

- 10 Polymorph A is also characterizable by one or more of the following FT-Raman Peak Positions:

table 2 – Raman spectra of polymorph A

Peak position (cm⁻¹)	Rel. Intensity (%)
145	35
170	22
216	22
237	16
256	23
285	14
339	27
370	24
420	14
442	12
465	14
505	37
526	19
710	11
810	43
974	10

1007	14
1059	16
1159	40
1228	38
1254	23
1277	23
1325	44
1387	30
1414	32
1448	25
1498	23
1537	63
1589	100
1628	50
2927	17

Preferably, polymorph A is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. More preferably, polymorph A is characterized by one or more of the peaks at 145, 505, 810, 1159, 1228, 1325, 1537, 1589, and 1628 cm^{-1} . Most preferably, polymorph A is characterized by the peaks at 810, 1325, 1537, 1589, and 1628 cm^{-1} .

One skilled in the art will recognize that the FT-Raman Peak Positions will generally be reproducible within a range from about $\pm 0 \text{ cm}^{-1}$ to $\pm 5 \text{ cm}^{-1}$, preferably from $\pm 1 \text{ cm}^{-1}$ to $\pm 3 \text{ cm}^{-1}$, most preferably $\pm 2 \text{ cm}^{-1}$. This also applies to the other Raman data presented in this specification.

Polymorph A is also characterizable by one or more of the following peak positions in Solid State ^{13}C -NMR:

table 3 - Solid State ^{13}C -NMR of polymorph A

Peak position (ppm)
174.0
163.9
150.4
148.8
144.5
140.2
134.8
133.2
129.8
124.9
124.0
122.1
114.6
22.5
15.7

Preferably, polymorph A is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. Most preferably, polymorph A is characterized by the peaks at 15.7, 114.6, 148.8 and 174.0 ppm.

One skilled in the art will recognize that the ^{13}C -ssNMR peaks will generally be reproducible within a range from about ± 0.1 ppm to ± 0.3 ppm, preferably ± 0.2 ppm. This also applies to the other NMR data presented in this specification.

10

In another embodiment, the present invention relates to a polymorph of the compound of the invention which is, in the following specification, referred to as polymorph B. A process for the preparation of polymorph B is given in the experimental section.

15 Polymorph B is a crystalline polymorph and, thus, characterizable by its powder X-ray diffraction pattern (XRPD). The diffraction pattern was recorded with Cu-K α radiation and is characterizable by one or more of the peaks given in the following table.

table 4 – XRPD of polymorph B

Peak Position (°2θ)	Rel. Intensity (%)
5.7	69
6.9	68
8.0	24
9.8	26
11.3	36
11.9	93
13.8	100
14.4	27
16.9	63
19.6	87
20.4	28

Preferably, polymorph B is characterized by one or more of the above peaks in the range of from about 5 to about 25 °/2θ which is a highly characteristic region of XRPDs. More preferably, polymorph B is characterized by 2 to 10, preferably 3 to 5, peaks within the range of from about 5 to about 25 °/2θ. Even more preferably, the polymorph B is characterized by the signals at 5.7, 6.9, 11.9, 13.8, 16.9 and 19.6 °/2θ. Most preferably, polymorph B is characterized by the signals at 5.7, 6.9, 13.8 and 19.6 °/2θ.

- 10 In addition, polymorph B may also be characterizable by having an exotherm at 237 °C in a Differential Scanning Calorimetry (DSC) thermogram. Such analyses may also indicate a shoulder peak at 231 °C.

- 15 In addition, polymorph B is preferably an anhydrate as is evidenced by a lack of solvent desorption in combined Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) experiments prior to energetic decomposition. However, molecular packaging of polymorph B allows the accommodation of crystal water without substantially altering the crystal lattice.

Polymorph B is also characterizable by one or more of the following FT-Raman Peak Positions:

table 5 – Raman spectra of polymorph B

Peak position (cm⁻¹)	Rel. Intensity (%)
141	26
214	23
235	16
253	20
280	14
339	25
361	18
372	19
399	15
415	18
440	12
463	15
505	49
526	21
710	14
812	54
887	11
926	13
970	12
1001	22
1059	19
1157	10
1227	14
1292	49
1317	43
1385	50
1406	34
1444	32
1504	27

1537	44
1583	100
1630	69
2933	31

Preferably, polymorph B is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. More preferably, polymorph B is characterized by one or more of the peaks at 505, 1292, 1317, 1385, 1537, 1583, and
 5 1630 cm^{-1} . Most preferably, polymorph B is characterized by the peaks at 505, 1292, 1385, 1583, and 1630 cm^{-1} .

Polymorph B is also characterizable by one or more of the following peak positions in Solid State ^{13}C -NMR:

10

table 6 - Solid State ^{13}C -NMR of polymorph B

Peak positions (ppm)
174.4
164.7
150.3
139.1
133.9
132.8
123.5
120.3
114.0
112.6
19.8
16.6

Preferably, polymorph B is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. Most preferably, polymorph B is
 15 characterized by the peaks at 150.3, 133.9, 112.6 and 19.8 ppm.

In yet another embodiment, the present invention relates to a polymorph of the compound of the invention which is, in the following specification, referred to as polymorph C. A process for the preparation of polymorph C is given in the experimental section.

- 5 Polymorph C is a crystalline polymorph and, thus, characterizable by one or more of the peaks of its powder X-ray diffraction pattern (XRPD). The diffraction pattern was recorded with Cu-K α radiation and is given in the following table.

table 7 – XRPD of polymorph C

Peak Position (°2θ)	Rel. Intensity (%)
4.9	100
7.3	22
9.5	13
9.9	8
10.3	10
13.3	61
13.8	6
14.5	13
17.2	8
18.0	19
19.1	34
19.9	13
20.7	19
21.9	5
22.6	21
23.4	11
24.0	44
24.6	16
24.9	31
25.3	24

25.8	8
26.7	25
27.2	16
27.6	8
28.4	23
28.8	9
29.3	11
29.9	5
30.5	5
31.8	8
32.8	8
33.9	6
34.6	5
35.4	5
35.8	5
36.6	5
37.6	5
38.2	3
38.7	6

Preferably, polymorph C is characterized by one or more of the above peaks in the range of from about 5 to about 25 °/2 θ which is a highly characteristic region of XRPDs. More preferably, polymorph C is characterized by 2 to 10, preferably 3 to 5, peaks within the
5 range of from about 5 to about 25 °/2 θ . Even more preferably, the polymorph C is characterized by the signals at 4.9, 7.3, 13.3, 19.1, 21.9, 23.4 and 24.0 °/2 θ . Most preferably, polymorph C is characterized by the signals at 4.9, 13.3, 19.1 and 24.0 °/2 θ .

Polymorph C may also be characterised by showing an exotherm at 203 °C in a Differential
10 Scanning Calorimetry (DSC) thermogram.

Polymorph C is also characterizable by one or more of the following FT-Raman Peak Positions:

table 8 – Raman spectra of polymorph C

Peak position (cm⁻¹)	Rel. Intensity (%)
143	38
214	19
237	14
253	17
282	14
299	13
339	30
370	20
401	13
418	14
444	10
465	12
507	40
530	15
667	13
710	14
739	11
810	41
972	11
1003	14
1061	20
1147	21
1244	42
1281	34
1317	36
1352	36
1387	55

1406	45
1450	30
1483	22
1506	24
1537	42
1585	100
1630	59
2918	15

Preferably, polymorph C is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. More preferably, polymorph C is characterized by one or more of the peaks at 143, 507, 810, 1244, 1281, 1317, 1352, 1387, 1406, 1537, 1585, and 1630 cm^{-1} . Most preferably, polymorph C is characterized by the peaks at 1387, 1406, 1537, 1585, and 1630 cm^{-1} .

Polymorph C is also characterizable by one or more of the following peak positions in Solid State ^{13}C -ssNMR:

table 9 - Solid State ^{13}C -NMR of polymorph C

Peak positions (ppm)
173.9
165.0
150.7
141.0
138.6
133.5
122.8
120.3
114.0
112.4
41.1
20.2
17.9

Preferably, polymorph C is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. Most preferably, polymorph C is characterized by the peaks at 150.7, 133.5, 114.0 and 20.2 ppm.

- 5 In yet another embodiment, the present invention relates to a polymorph of the compound of the invention which is, in the following specification, referred to as polymorph D. A process for the preparation of polymorph D is given in the experimental section.

10 Polymorph D is a crystalline polymorph and, thus, characterizable by one or more of the peaks of its powder X-ray diffraction pattern (XRPD). The diffraction pattern was recorded with Cu-K α radiation and is given in the following table.

table 10 – XRPD of polymorph D

Peak Position (°2θ)	Rel. Intensity (%)
11.6	21
12.3	23
20.0	43
20.7	100
21.4	69
23.8	25
24.8	26
26.6	11
27.4	12
28.0	12
29.1	31
31.1	56
32.0	20
33.3	39
35.0	23
36.0	35

Preferably, polymorph D is characterized by one or more of the above peaks in the range of from about 5 to about 25 °/2 θ which is a highly characteristic region of XRPDs. More preferably, polymorph D is characterized by 2 to 10, preferably 3 to 5, peaks within the range of from about 5 to about 25 °/2 θ . Even more preferably, the polymorph D is characterized by the signals at 11.6, 12.3, 20.0, 20.7, 21.4 and 24.8 °/2 θ . Most preferably, polymorph D is characterized by the signals at 12.3, 20.0, 20.7 and 21.4 °/2 θ .

In yet another embodiment, the present invention relates to a polymorph of the compound of the invention which is, in the following specification, referred to as polymorph E. A process for the preparation of polymorph E is given in the experimental section.

Polymorph E is a crystalline polymorph and, thus, characterizable by one or more of the peaks of its powder X-ray diffraction pattern (XRPD). The diffraction pattern was recorded with Cu-K α radiation and is given in the following table.

table 11 – XRPD of polymorph E

Peak Position (°2 θ)	Rel. Intensity (%)
4.5	8
5.4	34
6.2	36
6.9	4
7.8	52
8.4	3
9.8	100
10.8	89
11.2	69
11.5	11
12.2	87
12.4	31
13.8	22

14.6	44
15.6	16
16.2	4
17.1	5
17.6	15
18.7	30
19.8	48
20.1	37
21.7	8
22.6	21
22.9	26
24.0	16
24.5	30
25.1	16
26.0	81
27.3	68
28.8	13
30.6	9
31.5	11
32.7	8
33.5	20
34.1	21
35.8	8
36.9	9
39.2	7

Preferably, polymorph E is characterized by one or more of the above peaks in the range of from about 5 to about 25 °/2 θ which is a highly characteristic region of XRPDs. More preferably, polymorph E is characterized by 2 to 10, preferably 3 to 5, peaks within the
5 range of from about 5 to about 25 °/2 θ . Even more preferably, the polymorph E is characterized by the signals at 7.8, 9.8, 12.2, 15.6, 16.2, 17.6, 19.8, 21.7, 22.9, and

24.5 °/2 θ . Most preferably, polymorph E is characterized by the signals at 9.8, 11.2, 19.8 and 24.5 °/2 θ .

Polymorph E may be further characterised by showing an endotherm at 159 °C in a
 5 Differential Scanning Calorimetry (DSC) thermogram. Polymorph E may be even further characterised by showing an exotherm at 243 °C in a Differential Scanning Calorimetry (DSC) thermogram.

Polymorph E is also characterizable by one or more of the following FT-Raman Peak
 10 Positions:

table 12 – Raman spectra of polymorph E

Peak position (cm ⁻¹)	Rel. Intensity (%)
127	58
216	16
231	17
260	16
341	21
384	20
461	15
498	20
526	14
712	13
739	26
769	10
816	19
893	15
922	19
972	17
1005	27

1022	45
1057	17
1174	15
1209	23
1234	31
1269	34
1288	33
1327	35
1356	100
1412	35
1460	29
1506	31
1533	52
1556	58
1583	97
1635	79
2931	11

Preferably, polymorph E is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. More preferably, polymorph E is characterized by one or more of the peaks at 127, 1022, 1269, 1288, 1327, 1356, 1412, 5 1533, 1556, 1583, and 1635 cm^{-1} . Most preferably, polymorph E is characterized by the peaks at 1356, 1533, 1556, 1583, and 1635 cm^{-1} .

Polymorph E is also characterizable by one or more of the following peak positions in Solid State ^{13}C -NMR:

table 13 - Solid State ^{13}C -NMR of polymorph E

Peak Positions (ppm)
175.2
164.2
158.8
151.8
147.1
145.5
143.4
139.4
136.4
133.6
130.7
127.3
124.8
123.3
118.1
108.3
105.1
19.4
17.6

Preferably, polymorph E is characterizable by one or more, preferably 2 to 6, and more preferably 3 to 5, peak positions in the above table. Most preferably, polymorph C is
5 characterized by the peaks at 151.8, 133.6, 105.1 and 19.4 ppm.

In yet another embodiment, the present invention relates to a polymorph of the compound of the invention which is, in the following specification, referred to as polymorph F. A process for the preparation of polymorph F is given in the experimental section.

10

Polymorph F is a crystalline polymorph and, thus, characterizable by one or more of the peaks of its powder X-ray diffraction pattern (XRPD). The diffraction pattern was recorded with Cu-K α radiation and is given in the following table.

table 14 – XRPD of polymorph F

Peak Position (°2θ)	Rel. Intensity (%)
4.9	62
6.3	64
8.2	80
10.7	81
11.4	58
12.6	65
13.5	59
14.4	49
16.4	58
18.8	55
20.5	56
21.5	66
23.9	58
24.8	65
25.4	100
26.4	46
27.5	57
28.5	42
29.7	42
33.2	33
34.7	28

Preferably, polymorph F is characterized by one or more of the above peaks in the range of from about 5 to about 25 °/2θ which is a highly characteristic region of XRPDs. More preferably, polymorph F is characterized by 2 to 10, preferably 3 to 5, peaks within the range of from about 5 to about 25 °/2θ. Even more preferably, the polymorph F is characterized by the signals at 8.2, 10.7, 12.6, 13.5, 16.4 and 25.4 °/2θ. Most preferably, polymorph F is characterized by the signals at 10.7, 12.6, 16.4 and 25.4 °/2θ.

In interconversion experiments, it was found that the polymorphs C, D, E, and F convert into polymorph A or B, i.e. modifications A and B are kinetically stable polymorphs. Furthermore, it was found that polymorph B converts into polymorph A when slurried in water containing crystal seeds of modification A over prolonged periods of time. Thus, polymorph A is the thermodynamically stable polymorph.

In particular, drying of polymorph C under vacuum at ambient temperature or at 60 °C produced polymorph B, and drying of polymorph E under vacuum at ambient temperature or at 60 °C produced polymorph A.

Given the fact that modifications A and B are thermodynamically stable and kinetically stable, respectively, they will in particular be characterized by good storage stability. Storage stability of the polymorph is defined herein as a lack of rearrangement of one polymorphic modification into another modification under storage conditions of 60 % relative humidity and 25 °C over a period of 3 months. Accordingly, physical parameters related to the polymorphic modification such as the XRPD, Raman spectra and the Differential Scanning Calorimetry (DSC) thermogram will not change upon storage under the above-specified conditions.

Furthermore, these polymorphs will also exhibit stable dissolution properties as these properties are dependent on the above defined storage stability of the polymorph. Accordingly, the modifications A and B are also characterized in that they will not be subject to a change in their dissolution profile upon storage. A lack of change in the dissolution profile is defined herein as a variation of the time period until 80 % of the polymorph has dissolved under test conditions according to the USP Paddle Test Method, USP, 30th Edition, The National Formulary 25th Edition, 2007, The United States Pharmacopeial Convention, Rockville, volume 1, chapter 711, of less than 10 %, preferably less than 5 % and most preferably less than 1 %, after storage under conditions of 60 % relative humidity at 25 °C over a period of at least 3 months.

The polymorphs of the present invention may be used as active pharmaceutical ingredients in pharmaceutical formulations such as tablets, capsules or injections, without or in combination with one or more pharmaceutically acceptable additives such as sugar, starch, starch derivatives, cellulose, cellulose derivatives, release agents, anti-adhesive agents and agents for regulating flowability.

With regard to pharmaceutical formulations comprising polymorph A the present invention also relates to a pharmaceutical composition, characterized in that it comprises 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and that the X-ray powder diffractogram of the composition exhibits one or more, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, 2θ angles from the following list of 2θ angles: 6.6, 6.9, 11.8, 13.2, 17.2, 17.9, 19.8, 22.6, 23.2, 23.8, 24.3, and 25.3. Preferably, said formulation is characterized by an XRPD having one or more of the following characteristic peaks for polymorph A: 6.6, 23.2 and 24.3.

Furthermore, said pharmaceutical composition may further be characterized in that its Raman spectrum exhibits at least one, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, peaks from the following peak list [cm^{-1}]: 145, 170, 216, 237, 256, 285, 339, 370, 420, 442, 465, 505, 526, 710, 810, 974, 1007, 1059, 1159, 1228, 1254, 1277, 1325, 1387, 1414, 1448, 1498, 1537, 1589, 1628, 2927.

Furthermore, said pharmaceutical composition may also be further characterized in that its Solid State ^{13}C -NMR spectrum (100 MHz) exhibits at least one, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, peaks from the following peak list [ppm]: 174.0, 163.9, 150.4, 148.8, 144.5, 140.2, 134.8, 133.2, 129.8, 124.9, 124.0, 122.1, 114.6, 22.5, and 15.7.

The pharmaceutical formulations comprising polymorph A may also exhibit an exotherm at 251 °C in a Differential Scanning Calorimetry (DSC) thermogram.

In an alternative embodiment, with regard to pharmaceutical formulations comprising polymorph B, the present invention relates to a pharmaceutical composition, characterized in that it comprises 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and that its X-ray powder diffractogram exhibits one or more, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, 2 θ angles from the following list of 2 θ angles: 5.7, 6.9, 8.0, 9.8, 11.3, 11.9, 13.8, 14.4, 16.9, 19.6, and 20.4. Preferably, said formulation is characterized by an XRPD having one or more of the following characteristic peaks for polymorph B: 5.7, 16.9 and 19.6.

Furthermore, said pharmaceutical composition may further be characterized in that its Raman spectrum exhibits at least one, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, peaks from the following peak list [cm^{-1}]: 141, 214, 235, 253, 280, 339, 361, 372, 399, 415, 440, 463, 505, 526, 710, 812, 887, 926, 970, 1001, 1059, 1157, 1227, 1292, 1317, 1385, 1406, 1444, 1504, 1537, 1583, 1630, and 2933.

Furthermore, said pharmaceutical composition may also be further characterized in that its Solid State ^{13}C -NMR spectrum (100 MHz) exhibits at least one, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, peaks from the following peak list [ppm]: 174.4, 164.7, 150.3, 139.1, 133.9, 132.8, 123.5, 120.3, 114.0, 112.6, 19.8, and 16.6.

The pharmaceutical formulations comprising polymorph B may also exhibit an exotherm at 237 °C, in a Differential Scanning Calorimetry (DSC) thermogram.

In an alternative embodiment, with regard to pharmaceutical formulations comprising polymorph C, the present invention relates to a pharmaceutical composition, characterized in that it comprises 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and that its X-ray powder diffractogram exhibits one or more, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, 2 θ angles from the following list of 2 θ : 4.9, 7.3, 9.5, 9.9, 10.3, 13.3, 13.8, 14.5, 17.2, 18.0, 19.1, 19.9, 20.7, 21.9, 22.6, 23.4, 24.0, 24.6, 24.9, and 25.3. Preferably, said formulation is characterized by an XRPD having one or more of the following characteristic peaks for polymorph C: 7.3, 19.1, 21.9 and 23.4.

Furthermore, said pharmaceutical composition may further be characterized in that its Raman spectrum exhibits at least one, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, peaks from the following peak list [cm^{-1}]: 143, 214, 237, 253, 282, 299, 339, 370, 401, 418, 444, 465, 507, 530, 667, 710, 739, 810, 972, 1003, 1061, 1147, 1244, 1281, 1317, 1352, 1387, 1406, 1450, 1483, 1506, 1537, 1585, 1630, and 2918.

Furthermore, said pharmaceutical composition may also be further characterized in that its Solid State ^{13}C -NMR spectrum (100 MHz) exhibits at least one, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, peaks from the following peak list [ppm]: 173.9, 165.0, 150.7, 141.0, 138.6, 133.5, 122.8, 120.3, 114.0, 112.4, 41.1, 20.2, and 17.9.

The pharmaceutical formulations comprising polymorph C may also exhibit an exotherm at 203 °C in a Differential Scanning Calorimetry (DSC) thermogram.

In an alternative embodiment, with regard to pharmaceutical formulations comprising polymorph D, the present invention relates to a pharmaceutical composition, characterized in that it comprises 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and that its X-ray powder diffractogram exhibits one or more, preferably 2 to 10, more preferably 3 to 5, and most preferably 4, 2θ angles from the following list of 2θ angles: 11.6, 12.3, 20.0, 20.7, 21.4, 23.8, 24.8, 26.6, 27.4, 28.0, 29.1, 31.1, 32.0, 33.3, 35.0, and 36.0.

In an alternative embodiment, with regard to pharmaceutical formulations comprising polymorph E, the present invention relates to a pharmaceutical composition, characterized in that it comprises 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and that its X-ray powder diffractogram exhibits one or more, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, 2θ angles from the following list of 2θ angles: 4.5, 5.4, 6.2, 6.9, 7.8, 8.4, 9.8, 10.8, 11.2, 11.5, 12.2, 12.4, 13.8, 14.6, 15.6, 16.2, 17.1, 17.6, 18.7, 19.8, 20.1, 21.7, 22.6, 22.9, 24.0, 24.5, 25.1, 26.0, 27.3, 28.8, 30.6, 31.5, 32.7, 33.5, 34.1, 35.8, 36.9, and 39.2. Preferably, said formulation is characterized by an XRPD having one or more of the following characteristic peaks for polymorph E: 7.8, 15.6, 16.2, 17.6, 21.7 and 22.9.

Furthermore, said pharmaceutical composition may further be characterized in that its Raman spectrum exhibits at least one, preferably 1 to 6, more preferably 2 to 4, and most preferably 3, peaks from the following peak list [cm^{-1}]: 127, 216, 231, 260, 341, 384, 461, 498, 526, 712, 739, 769, 816, 893, 922, 972, 1005, 1022, 1057, 1174, 1209, 1234, 1269, 1288, 1327, 1356, 1412, 1460, 1506, 1533, 1556, 1583, 1635, and 2931.

Furthermore, said pharmaceutical composition may also be further characterized in that its Solid State ^{13}C -NMR spectrum (100 MHz) exhibits at least one, preferably 2 to 10, more preferably 3 to 5, and most preferably 4, peaks from the following peak list [ppm]: 175.2, 164.2, 158.8, 151.8, 147.1, 145.5, 143.4, 139.4, 136.4, 133.6, 130.7, 127.3, 124.8, 123.3, 118.1, 108.3, 105.1, 19.4, and 17.6.

The pharmaceutical formulations comprising polymorph E may also exhibit an exotherm at 243 °C in a Differential Scanning Calorimetry (DSC) thermogram.

In an alternative embodiment, with regard to pharmaceutical formulations comprising polymorph F, the present invention relates to a pharmaceutical composition, characterized in that it comprises 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and that its X-ray powder diffractogram exhibits one or more, preferably 2 to 10, more preferably 3 to 5, and most preferably 4, 2θ angles from the following list of 2θ angles: 4.9, 6.3, 8.2, 10.7, 11.4, 12.6, 13.5, 14.4, 16.4, 18.8, 20.5, 21.5, 23.9, 24.8, 25.4, 26.4, 27.5, 28.5, 29.7, 33.2, and 34.7. Preferably, said formulation is characterized by an XRPD having one or more of the following characteristic peaks for polymorph F: 8.2, 12.6, 13.5, and 16.4.

When properly formulated by the skilled person, the physical properties of the polymorphs are reflected in the pharmaceutical formulations. Accordingly, pharmaceutical formulations comprising the stable polymorphs A and/or B will also be storage stable. Thus, pharmaceutical formulations containing modifications A and/or B are further characterized in that they will not be subject to a change in their dissolution profile upon storage. A lack of change in the dissolution profile is defined herein as a lack of variation of the time period until 80 % of the active pharmaceutical ingredient has been released under test

conditions according to the USP Paddle Test Method, USP, 30th Edition, The National Formulary 25th Edition, 2007, The United States Pharmacopeial Convention, Rockville, volume 1, chapter 711, of less than 10 %, preferably less than 5 % and most preferably less than 1 %, after storage under conditions of 60 % relative humidity at 25 °C over a period of
5 at least 3 months.

Furthermore, the stability of modifications A and B can be used to convert metastable modifications such as modifications C to F into the more stable modifications A or B. Likewise, due to the stability of modifications A and B, mixtures of metastable
10 modifications can be converted to polymorphically pure modifications A and B e.g. by seeding slurries of such mixtures with modification A or B. Modification B can also be converted to modification A e.g. by seeding a slurry of modification B with seeding crystals of modification A.

15 It is particularly preferred to convert modifications less stable than modification A such as amorphous, metastable and polymorphically impure modifications to the thermodynamically most stable modification A. The most preferred process for doing so is seeding such modifications or mixtures of modifications with seeding crystals of modification A. Another preferred process for achieving a conversion is the dissolution of said
20 modifications, followed by seeding with crystals of modification A.

Experimental section:

25 Process for the preparation of polymorph A:

A 1600L reactor was charged with 245kg formic acid and 10 kg 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol. The mixture was heated to 70-75 °C until the solid dissolved. The hot solution was then filtered to a
30 250L reactor, and then cooled to 25-35°C. Vacuum was applied and the mixture was distilled at 50°C until 50-70 litres remained. To this mixture 160kg isopropanol was introduced. The mixture was cooled to 5-10°C and was allowed to stir for 10 hours. The

suspension was then centrifuged and washed with 13kg isopropanol. The wet material was removed from the centrifuge and dried in a vacuum tray drier. The dried material weight was 8.995kg after sampling. The yield of polymorph A was 9.395kg, 93.9%.

5

Process for the preparation of polymorph B:

161.6 mg of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol were added to a glass vial. Formic acid (2.0 mL) was added and the
10 sample warmed to 73°C in an oil bath. The resulting mixture was filtered through a 0.2 µm nylon filter into a clean vial at room temperature. Solids of polymorph B were precipitated via addition of water (2.0 mL) and were collected by filtration.

15 Process for the preparation of polymorph C:

161.0 mg of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol were added to a glass vial and dissolved in DMSO (4.0 mL). The solution was filtered through a 0.2 µm nylon filter into a clean vial and evaporated to
20 dryness in a centrifugal evaporator set at 50°C under vacuum to yield polymorph C.

Process for the preparation of polymorph D:

25 A saturated solution of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol was generated in a 1:1 dioxane:water mixture (1.0 mL). The resulting mixture was filtered through a 0.2 µm nylon filter into a clean vial and evaporated to dryness under ambient conditions to yield polymorph D.

30

Process for the preparation of polymorph E:

151.2 mg of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol were added to a glass vial and dissolved in pyridine (3.0 mL). The solution was filtered through a 0.2 µm nylon filter into a clean vial and evaporated to dryness under a nitrogen stream yielding polymorph E.

Process for the preparation of polymorph F:

A saturated solution of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol was generated in DMSO (0.500 mL). The resulting mixture was filtered through a 0.2 µm nylon filter into a clean vial. Approximately 60 µL of this solution was dispensed into a capillary. The capillary was placed into a centrifugal evaporator at ambient temperature and the solvent removed under reduced pressure yielding polymorph F.

Analysis was performed with the following instrumentation:

1. PANalytical X'Pert Pro Diffractometer

Samples of polymorphs A, C and E were analyzed using a PANalytical X'Pert Pro diffractometer. The specimen was analyzed using Cu radiation produced using an Optix long fine-focus source. An elliptically graded multilayer mirror was used to focus the Cu Kα X-rays of the source through the specimen and onto the detector. The specimen was sandwiched between 3-micron thick films, analyzed in transmission geometry, and rotated to optimize orientation statistics. A beam-stop and helium were used to minimize the background generated by air scattering. Soller slits were used for the incident and diffracted beams to minimize axial divergence. Diffraction patterns were collected using a scanning position-sensitive detector (X'Celerator) located 240 mm from the specimen. The data-acquisition parameters of each diffraction pattern are displayed above the image of each pattern in appendix data section. Prior to the analysis a silicon specimen (NIST

standard reference material 640c) was analyzed to verify the position of the silicon 111 peak.

5 2. Shimadzu XRD-6000 Diffractometer

Samples of polymorph B were analyzed using a Shimadzu XRD-6000 X-ray powder diffractometer using Cu K α radiation. The instrument is equipped with a long fine focus X-ray tube. The tube voltage and amperage were set at 40 kV and 40 mA, respectively.

10 The divergence and scattering slits were set at 1° and the receiving slit was set at 0.15 mm. Diffracted radiation was detected by a NaI scintillation detector. A theta-two theta continuous scan at 3 °/min (0.4 sec/0.02° step) from 2.5 to 40 °2 θ was used. A silicon standard was analyzed to check the instrument alignment. Samples were prepared for analysis by placing them in an aluminum/silicon sample holder.

15

3. Bruker D8 Discover Diffractometer

Samples of polymorph D were analyzed using a Bruker D-8 Discover diffractometer and
20 Bruker's General Area Diffraction Detection System (GADDS, v. 4.1.20). An incident beam of CuK α radiation was produced using a fine-focus tube (40 kV, 40 mA), a Göbel mirror, and a 0.5 mm double-pinhole collimator. The sample was packed between 3-micron thick films to form a portable disc-shaped specimen and analyzed using a transmission geometry. The incident beam was scanned and rastered over the sample
25 during the analysis to optimize orientation statistics. A beam-stop was used to minimize air scatter from the incident beam at low angles. Diffraction patterns were collected using a Hi-Star area detector located 15 cm from the sample and processed using GADDS. The intensity in the GADDS image of the diffraction pattern was integrated using a step size of 0.04° 2 θ . The integrated patterns display diffraction intensity as a function of 2 θ . Prior to
30 the analysis a silicon standard was analyzed to verify the Si 111 peak position.

4. Inel XRG-3000 Diffractometer

X-ray powder diffraction (XRPD) analyses of polymorph F were performed using an Inel XRG-3000 diffractometer equipped with a CPS (Curved Position Sensitive) detector with a 2 θ range of 120°. Real time data were collected using Cu-K α radiation. The tube voltage and amperage were set to 40 kV and 30 mA, respectively. The monochromator slit was set at 1-5 mm by 160 μ m. The patterns are displayed from 2.5-40 °2 θ . Samples were prepared for analysis by packing them into thin-walled glass capillaries. Each capillary was mounted onto a goniometer head that is motorized to permit spinning of the capillary during data acquisition. The samples were analyzed for 300 seconds. Instrument calibration was performed using a silicon reference standard.

DSC for polymorph A was performed using TA Instruments model Q2000 calorimeter. The samples were placed in an aluminium DSC pan, the weight accurately recorded and the pan crimped. The sample cell was equilibrated at 25 °C and heated under nitrogen purge at a rate of 10 °C/min up to a final temperature of 250 or 300 °C. Indium metal was used as calibration standard. For all other polymorphs analyses were performed using TA Instruments model 2920 calorimeter. The sample cell was equilibrated at 25 °C and heated under nitrogen purge at a rate of 10 °C/min up to a final temperature of 250 or 300 °C. Indium metal was used as calibration standard.

TGA analyses were performed on a TA Instruments model 2950 thermogravimetric analyzer. The furnace was equilibrated at 25 °C and heated under nitrogen purge at a rate of 10 °C/min up to a final temperature of 300 or 350 °C. Nickel and AlumelTM were used as calibration standards.

Hotstage microscopy was performed using a Linkam hotstage (model FTIR 600) mounted to a Leica DMLP microscope. Samples were observed using crossed polarized light. Samples were sandwiched between coverslips and visually observed as the stage was heated. The hotstage was calibrated using USP melting point standards.

FT-Raman spectra were acquired on an FT-Raman 960 spectrometer (Thermo Nicolet) using an excitation wavelength of 1064 nm. Approximately 0.2-0.3 W of Nd:YVO₄ laser power was used to irradiate the samples. The Raman spectra were measured with a germanium detector. The samples were prepared for analysis by placing the material in a glass tube and positioning the tube in a gold-coated tube holder in the accessory. A total of 256 sample scans were collected from 3600 – 100 cm⁻¹ at a spectral resolution of 4 cm⁻¹, using Happ-Genzel apodization. Wavelength calibration was performed using sulfur and cyclohexane.

For ¹³C-ss MAS NMR spectroscopy, samples were prepared by packing them into 4 mm PENCIL type zirconia rotors. Acquisition was performed on INOVA-400 at ambient temperature using VNMR6.1C (patch a11205) as processing software. The acquisition parameters were as follows:

Sequence: xpolvt1rho1
Relax. Delay: 40.000 sec
Pulse width: 2.2 usec (90.0 deg.) or 2.2usec (76.2 deg) for polymorph E
Acq. Time: 0.030 sec
Spectral width: 44994.4 Hz (447.517ppm)
400 scans
2 dummy scans
Acquired points: 2700
Observed Nucleus: C13 (100 MHz)
Decoupled Nucleus: H1 (400 MHz)
SPINAL-64 decoupling
Cross Polarization
Tangent RAMP-CP on C13
Contact time: 5.0 ms
Spinning rate: 12000 Hz

CLAIMS

1. Crystal modification of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-
[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol, characterized in that its X-ray
5 powder diffractogram exhibits the following 2θ angles: 6.6, 13.2, 17.9 and 23.8.
2. Crystal modification according to claim 1, further characterized in that its X-ray
powder diffractogram exhibits the following 2θ angles: 23.2 and 24.3.
- 10 3. Crystal modification according to any one of claims 1 to 2, further characterized in
that it exhibits an exotherm at 251 °C in a Differential Scanning Calorimetry (DSC)
thermogram.
4. Crystal modification according to any preceding claim, further characterized by
15 Raman peaks at 810, 1325, 1537, 1589, and 1628 cm^{-1} .
5. Crystal modification according to any preceding claim, further characterized by
peaks at 15.7, 114.6, 148.8 and 174.0 ppm in Solid State ^{13}C -NMR.
- 20 6. Crystal modification according to any preceding claim, further characterized in that
it exhibits a melt onset at 238 °C in hotstage analysis.
7. Crystal modification according to any preceding claim, further characterized in that
it does not rearrange into another polymorph under conditions of 60 % relative
25 humidity and 25 °C over a period of 3 months.

8. Crystal modification of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol, characterized in that its X-ray powder diffractogram exhibits the following 2θ angles: 5.7, 6.9, 13.8 and 19.6.
- 5 9. Crystal modification according to claim 8, further characterized in that its X-ray powder diffractogram exhibits the following 2θ angles: 11.9, and 16.9.
10. Crystal modification according to claim 8 or 9, further characterized by Raman peaks at 505, 1292, 1385, 1583, and 1630 cm^{-1} .
- 10 11. Crystal modification according to any one of claims 8 to 10, further characterized by peaks at 150.3, 133.9, 112.6 and 19.8 ppm in Solid State ^{13}C -NMR.
12. Crystal modification according to any one of claims 8 to 11, further characterized in that it exhibits an exotherm at 237 °C in a Differential Scanning Calorimetry (DSC) thermogram.
15
13. Crystal modification of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol, characterized in that its X-ray powder diffractogram exhibits the following 2θ angles: 4.9, 13.3, 19.1 and 24.0.
- 20 14. Crystal modification according to claim 13, further characterized in that its X-ray powder diffractogram exhibits the following 2θ angles: 7.3, 21.9 and 23.4.
15. Crystal modification according to claim 13 or 14, further characterized by Raman peaks at 1387, 1406, 1537, 1585, and 1630 cm^{-1} .
- 25 16. Crystal modification according to any one of claims 13 to 15, further characterized by peaks at 150.7, 133.5, 114.0 and 20.2 ppm in Solid State ^{13}C -NMR.

17. Crystal modification according to any one of claims 13 to 16, further characterized in that it exhibits an exotherm at 203 °C in a Differential Scanning Calorimetry (DSC) thermogram.
- 5 18. Crystal modification of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol, characterized in that its X-ray powder diffractogram exhibits the following 2θ angles: 12.3, 20.0, 20.7 and 21.4.
- 10 19. Crystal modification according to claim 18, further characterised in that its X-ray powder diffractogram exhibits the following 2θ angles: 11.6 and 24.8.
20. Crystal modification of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol, characterized in that its X-ray powder diffractogram exhibits the following 2θ angles: 9.8, 12.2, 19.8 and 24.5.
- 15 21. Crystal modification according to claim 20, further characterised in that its X-ray powder diffractogram exhibits the following 2θ angles: 7.8, 15.6, 16.2, 17.6, 21.7 and 22.9.
- 20 22. Crystal modification according to claim 20 or 21, further characterized by Raman peaks at 1356, 1533, 1556, 1583, and 1635 cm⁻¹.
23. Crystal modification according to any one of claims 20 to 22, further characterized by peaks at 151.8, 133.6, 105.1 and 19.4 ppm in Solid State ¹³C-NMR.
- 25 24. Crystal modification according to any one of claims 20 to 23, further characterised in that it exhibits an exotherm at 243 °C in a Differential Scanning Calorimetry (DSC) thermogram.
- 30 25. Crystal modification according to any one of claims 20 to 24, further characterised in that it exhibits an endotherm at 159 °C in a Differential Scanning Calorimetry (DSC) thermogram.

26. Crystal modification of 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol, characterized in that its X-ray powder diffractogram is exhibiting the following 2θ angles: 10.7, 12.6, 16.4 and 25.4.
27. Crystal modification according to claim 20, further characterised in that its X-ray powder diffractogram exhibits the following 2θ angles: 8.2 and 13.5.
28. Pharmaceutical composition comprising a crystal modification according to any one of claims 1 to 27.
29. Pharmaceutical composition comprising 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and characterized in that its X-ray powder diffractogram exhibits at least 3 2θ angles from the following list of 2θ angles: 6.6, 6.9, 11.8, 13.2, 17.2, 17.9, 19.8, 22.6, 23.2, 23.8, 24.3, and 25.3; and in that it exhibits an exotherm at 251 °C in a Differential Scanning Calorimetry (DSC) thermogram.
30. Pharmaceutical composition according to claim 29 wherein its XRPD exhibits the following peaks: 6.6, 23.2 and 24.3.
31. Pharmaceutical composition according to claim 29 or 30, further characterized in that its Raman spectrum exhibits at least 3 peaks from the following peak list [cm^{-1}]: 145, 170, 216, 237, 256, 285, 339, 370, 420, 442, 465, 505, 526, 710, 810, 974, 1007, 1059, 1159, 1228, 1254, 1277, 1325, 1387, 1414, 1448, 1498, 1537, 1589, 1628, 2927.
32. Pharmaceutical composition according to any one of claims 29 to 31, further characterized in that its Solid State ^{13}C -NMR spectrum (100 MHz) exhibits at least 3 peaks from the following peak list [ppm]: 174.0, 163.9, 150.4, 148.8, 144.5, 140.2, 134.8, 133.2, 129.8, 124.9, 124.0, 122.1, 114.6, 22.5, and 15.7

33. Pharmaceutical composition comprising 5-[3-(2,5-dichloro-4,6-dimethyl-1-oxy-pyridin-3-yl)-[1,2,4]oxadiazol-5-yl]-3-nitrobenzene-1,2-diol and characterized in that its X-ray powder diffractogram exhibits at least 3 2θ angles from the following list of 2θ angles: 5.7, 6.9, 8.0, 9.8, 11.3, 11.9, 13.8, 14.4, 16.9, 19.6, and 20.4; and in that it exhibits an exotherm at 237 ° in a Differential Scanning Calorimetry (DSC) thermogram.
34. Pharmaceutical composition according to claim 33 wherein its XRPD exhibits the following peaks: 5.7, 16.9 and 19.6.
35. Pharmaceutical composition according to claim 33 or 34, further characterized in that its Raman spectrum exhibits at least 3 peaks within from the following peak list [cm^{-1}]: 141, 214, 235, 253, 280, 339, 361, 372, 399, 415, 440, 463, 505, 526, 710, 812, 887, 926, 970, 1001, 1059, 1157, 1227, 1292, 1317, 1385, 1406, 1444, 1504, 1537, 1583, 1630, and 2933.
36. Pharmaceutical composition according to any one of claims 33 to 35, further characterized in that its Solid State ^{13}C -NMR spectrum (100 MHz) exhibits at least 3 peaks from the following peak list [ppm]: 174.4, 164.7, 150.3, 139.1, 133.9, 132.8, 123.5, 120.3, 114.0, 112.6, 19.8, and 16.6.
37. Pharmaceutical composition according to any one of claims 29 to 36, further characterized in that the variation of the time period until 80 % of the active pharmaceutical ingredient has been released under test conditions according to the USP Paddle Test Method, USP, 30th Edition, The National Formulary 25th Edition, 2007, The United States Pharmacopeial Convention, Rockville, volume 1, chapter 711, is less than 10 % after storage under conditions of 60 % relative humidity at 25 °C over a period of at least 3 months.

38. Process for the conversion of a crystal modification according to any one of claims 13 to 17 to the modification according to any one of claims 8 to 12, comprising the step of drying the crystal modification according to any one of claims 13 to 17 under vacuum.
- 5
39. Process according to claim 37 wherein the drying takes place at a temperature range of ambient temperatures to 60 °C.
40. Process for the conversion of a crystal modification according to any one of claims 20 to 25 to the modification according to any one of claims 1 to 7, comprising the step of drying the crystal modification according to any one of claims 20 to 25 under vacuum.
- 10
41. Process according to claim 40 wherein the drying takes place at a temperature range of ambient temperatures to 60 °C.
- 15
42. Process for the conversion of a crystal form according to any one of claims 8 to 27 to a crystal form according to any one of claims 1 to 7, comprising the step of seeding a slurry of a crystal form according to any one of claims 8 to 27 with a crystal form according to any one of claims 1 to 7.
- 20
43. Polymorph according to any one of claims 1 to 27 or a pharmaceutical composition according to any one of claims 28 to 37 for treating a subject afflicted by a central or peripheral nervous system disorder.
- 25
44. Polymorph or a pharmaceutical composition according to claim 43 for treating mood disorders, Parkinson's disease and parkinsonian disorders, gastrointestinal disturbances, edema formation states and hypertension.
- 30
45. Polymorph or a pharmaceutical composition according to claim 43 or 44 for use in L-DOPA/AADC therapy.

INTERNATIONAL SEARCH REPORT

International application No
PCT/PT2009/000013

A. CLASSIFICATION OF SUBJECT MATTER

INV. C07D413/04 A61K31/4439 A61P25/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, A	WO 2008/094053 A (PORTELA & CA SA [PT]; LEARMONTH DAVID ALEXANDER [PT]; KISS LASZLO ERNO) 7 August 2008 (2008-08-07) page 24; example 1	1-45
A	WO 2007/013830 A (PORTELA & CA SA [PT]; LEARMONTH DAVID ALEXANDER [PT]; KISS LASZLO ERNO) 1 February 2007 (2007-02-01) cited in the application page 51; example 45	1-45

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *S* document member of the same patent family

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7 May 2009

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/PT2009/000013

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