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(54) Benævnelse: **2-(2,4,5-SUBSTITUERET-ANILINO)PYRIMIDINFORBINDELSER**

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# DESCRIPTION

**[0001]** The present disclosure relates to certain 2-(2,4,5-substituted-anilino)pyrimidine compounds and pharmaceutically salts thereof which may be useful in the treatment or prevention of a disease or medical condition mediated through certain mutated forms of epidermal growth factor receptor (for example the L858R activating mutant, the Exon19 deletion activating mutant and the T790M resistance mutant). Such compounds and salts thereof may be useful in the treatment or prevention of a number of different cancers. The disclosure also relates to pharmaceutical compositions comprising said compounds and salts thereof, especially useful polymorphic forms of these compounds and salts, intermediates useful in the manufacture of said compounds and to methods of treatment of diseases mediated by various different forms of EGFR using said compounds and salts thereof.

**[0002]** EGFR is a transmembrane protein tyrosine kinase member of the erbB receptor family. Upon binding of a growth factor ligand such as epidermal growth factor (EGF), the receptor can homo-dimerise with another EGFR molecule or hetero-dimerise with another family member such as erbB2 (HER2), erbB3 (HER3), or erbB4 (HER4).

**[0003]** Homo- and/or hetero-dimerisation of erbB receptors results in the phosphorylation of key tyrosine residues in the intracellular domain and leads to the stimulation of numerous intracellular signal transduction pathways involved in cell proliferation and survival. Deregulation of erbB family signalling promotes proliferation, invasion, metastasis, angiogenesis, and tumour cell survival and has been described in many human cancers, including those of the lung, head and neck and breast.

**[0004]** The erbB family therefore represents a rational target for anticancer drug development and a number of agents targeting EGFR or erbB2 are now clinically available, including gefitinib (IRESSA™), erlotinib (TARCEVA™) and lapatinib (TYKERB™, TYVERB™). Detailed reviews of erbB receptor signalling and its involvement in tumourigenesis are provided in New England Journal of Medicine (2008) Vol. 358,1160-74 and Biochemical and Biophysical Research Communications (2004) Vol. 319, 1-11.

**[0005]** In 2004 it was reported (Science [2004] Vol.304, 1497-500 and New England Journal of Medicine [2004] Vol. 350, 2129-39) that activating mutations in EGFR correlated with response to gefitinib therapy in non-small-cell lung cancer (NSCLC). The most common EGFR activating mutations, L858R and delE746_A750, result in an increase in affinity for small molecule tyrosine kinase inhibitors such as gefitinib and erlotinib and a decrease in affinity for adenosine triphosphate (ATP) relative to wild type (WT) EGFR. Ultimately, acquired resistance to therapy with gefitinib or erlotinib arises, for example by mutation of the gatekeeper residue T790M, which is reportedly detected in 50% of clinically resistant patients. This mutation is not believed to hinder the binding of gefitinib or erlotinib to EGFR sterically, merely to alter the affinity to ATP to levels comparable to WT EGFR.

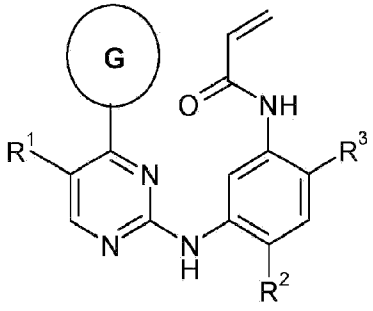
**[0006]** In view of the importance of this mutation in resistance to existing therapies targeting EGFR, we believe that agents which can inhibit EGFR harbouring the gatekeeper mutation may be especially useful in the treatment of cancer.

**[0007]** There remains a need for compounds that may exhibit favourable potency profiles against WT EGFR versus activating mutant forms of EGFR (for example the L858R EGFR mutant, or the delE746_A750 mutant or the Exon19 deletion EGFR mutant) and /or resistant mutant forms of EGFR (for example T790M EGFR mutant), and/or selectivity over other enzyme receptors which may make the compounds especially promosing for development as therapeutic agents. In this regard, there remains a need for compounds that show a higher inhibition of certain activating or resistance mutant forms of EGFR while at the same time showing relatively low inhibition of WT EGFR. Such compounds may be expected to be more suitable as therapeutic agents, particularly for the treatment of cancer, due to reduction of toxicology associated with WT EGFR inhibition. Such toxicologies are known to manifest themselves in man as skin rashes and/or diarrhoea. The applicants have surprisingly found that one or more 2-(2,4,5-substituted-anilino)pyrimidine compounds have high potency against several mutant forms of EGFR, while at the same showing relatively low inhibition of WT EGFR.

**[0008]** The compound(s) of the invention may also exhibit advantageous physical properties (for example, higher aqueous solubility, higher permeability, and/or lower plasma protein binding) and/or favourable toxicity profiles (for example a decreased hERG blocking liability) and/or favourable metabolic profiles in comparison with other known EGFR / EGFR-mutant inhibitors. Therefore, such compound(s) may be especially useful in the treatment of disease states in which EGFR and/or activating mutations of EGFR and/or resistance mutations of EGFR are implicated, for example in the treatment of cancer.

**[0009]** The present invention provides a polymorphic form of a mesylate salt of N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide, which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 7.2° or 8.6°, plus or minus 0.2° 2-theta, measured using CuKa radiation.

**[0010]** Disclosed herein is a compound of Formula **(I):**




**(I)**

wherein:

**G** is selected from 4,5,6,7-tetrahydropyrazolo[1,5-*a*]pyridin-3-yl, 1*H*-indol-3-yl,

1-methyl-1*H*-indol-3-yl and pyrazolo[1,5-*a*]pyridin-3-yl;

**$R^1$** is selected from hydrogen, fluoro, chloro, methyl and cyano;

**$R^2$** is selected from methoxy and methyl; and

**$R^3$** is selected from (3*R*)-3-(dimethylamino)pyrrolidin-1-yl, (3*S*)-3-(dimethylamino)pyrrolidin-1-yl, 3-(dimethylamino)azetidin-1-yl, [2-(dimethylamino)ethyl]-(methyl)amino, [2-(methylamino)ethyl](methyl)amino, 5-methyl-2,5-diazaspiro[3.4]oct-2-yl, (3aR,6aR)-5-methylhexa-hydro-pyrrolo[3,4-*b*]pyrrol-1(2*H*)-yl, 1-methyl-1,2,3,6-tetrahydropyridin-4-yl, 4-methylpiperizin-1-yl, 4-[2-(dimethylamino)-2-oxoethyl]piperazin-1-yl, methyl[2-(4-methylpiperazin-1-yl)ethyl]amino, methyl[2-(morpholin-4-yl)ethyl]amino, 1-amino-1,2,3,6-tetrahydropyridin-4-yl and 4-[(2*S*)-2-aminopropanoyl]piperazin-1-yl;

or a pharmaceutically acceptable salt thereof.

**[0011]** In one embodiment of the disclosure there is provided the mesylate salt of *N*-(2-{2-dimethylamino-ethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)-prop-2-enamide.

**[0012]** It will be understood that the compound of Formula **(I),** and pharmaceutically acceptable salts thereof, may exist in solvated forms and unsolvated forms. For example a solvated form may be a hydrated form. It is to be understood that the present invention encompasses all such solvated and unsolvated forms.

**[0013]** The compound of Formula **(I)** may be administered in the form of a prodrug which is broken down in the human or animal body to give a compound of the Formula **(I).** Examples of prodrugs include *in-vivo* hydrolysable esters of a compound of the Formula **(I).** *In-vivo* hydrolysable esters may be formed by esterification of the hydroxyl group in the compound of Formula **(I).** Various forms of prodrugs are known in the art. For examples of such prodrug derivatives, see:

1. a) Design of Prodrugs, edited by H. Bundgaard, (Elsevier, 1985) and Methods in Enzymology, Vol. 42, p. 309-396, edited by K. Widder, et al. (Academic Press, 1985);
2. b) A Textbook of Drug Design and Development, edited by Krogsgaard-Larsen and H. Bundgaard, Chapter 5 "Design and Application of Prodrugs", by H. Bundgaard p. 113-191 (1991);
3. c) H. Bundgaard, Advanced Drug Delivery Reviews, 8, 1-38 (1992);
4. d) H. Bundgaard, et al., Journal of Pharmaceutical Sciences, 77, 285 (1988); and N. Kakeya, et al., Chem Pharm Bull, 32, 692 (1984).

**[0014]** One aspect of the disclosure provides compounds of Formula **(I)** that inhibit one or

more activating or resistance mutations of EGFR, for example the L858R activating mutant, the Exon19 deletion EGFR activating mutant and the T790M resistance mutant. Advantageously such compounds may be useful for the treatment of cancer in a patient who has developed, or may be at risk of developing a level of resistance to an existing therapy based on an EGFR inhibitor.

**[0015]** In one aspect of the disclosure there are provided compounds of Formula **(I)** that show a higher inhibition of activating or resistance mutant forms of EGFR than of WT EGFR. Such compounds may be expected to be more suitable as therapeutic agents, particularly for the treatment of cancer, due to reduction of toxicology associated with WT EGFR inhibition. Such toxicologies are known to manifest themselves in man as skin rashes and/or diarrhoea.

**[0016]** According to a further aspect of the disclosure there is provided a pharmaceutical composition, which comprises the compound of the Formula **(I),** or a pharmaceutically acceptable salt thereof, as defined hereinbefore in association with a pharmaceuticallyacceptable diluent or carrier.

**[0017]** The compositions of the invention may be in a form suitable for oral use (for example as tablets, lozenges, hard or soft capsules, aqueous or oily suspensions, emulsions, dispersible powders or granules, syrups or elixirs), for topical use (for example as creams, ointments, gels, or aqueous or oily solutions or suspensions), for administration by inhalation (for example as a finely divided powder or a liquid aerosol), for administration by insufflation (for example as a finely divided powder) or for parenteral administration (for example as a sterile aqueous or oily solution for intravenous, subcutaneous, intramuscular or intramuscular dosing or as a suppository for rectal dosing).

**[0018]** The compositions of the invention may be obtained by conventional procedures using conventional pharmaceutical excipients, well known in the art. Thus, compositions intended for oral use may contain, for example, one or more colouring, sweetening, flavouring and/or preservative agents.

**[0019]** The compound of Formula **(I)** will normally be administered to a warm-blooded animal at a unit dose within the range 5-5000 mg/m$^2$ body area of the animal, i.e. approximately 0.1-100 mg/kg, and this normally provides a therapeutically-effective dose. A unit dose form such as a tablet or capsule will usually contain, for example 1-250 mg of active ingredient. The daily dose will necessarily be varied depending upon the host treated, the particular route of administration, and the severity of the illness being treated. Accordingly the practitioner who is treating any particular patient may determine the optimum dosage.

**[0020]** In the context of the present specification, the term "therapy" also includes "prophylaxis" unless there are specific indications to the contrary. The terms "therapeutic" and "therapeutically" should be construed accordingly.

**[0021]** As used herein, the term "treatment" is intended to have its normal everyday meaning

of dealing with a disease in order to entirely or partially relieve one, some or all of its symptoms, or to correct or compensate for the underlying pathology.

**[0022]** As used herein, the term "prophylaxis" is intended to have its normal everyday meaning and includes primary prophylaxis to prevent the development of the disease and secondary prophylaxis whereby the disease has already developed and the patient is temporarily or permamently protected against exacerbation or worsening of the disease or the development of new symptoms associated with the disease.

**[0023]** As a result of its inhibitory activity against the L858R EGFR mutant, the T790M EGFR mutant and the Exon19 deletion activating mutant, the compound of Formula (I), and pharmaceutically acceptable salts thereof, are expected to be useful in the treatment of diseases or medical conditions mediated alone or in part by EGFR mutant activity, for example cancer. The types of cancers which may be susceptible to treatment using the compound of Formula **(I),** or pharmaceutically acceptable salts thereof, include, but are not limited to, ovarian cancer, cervical cancer, colorectal cancer, breast cancer, pancreatic cancer, glioma, glioblastoma, melanoma, prostate cancer, leukaemia, lymphoma, non-Hodgkins lymphoma, gastric cancer, lung cancer, hepatocellular cancer, gastric cancer, gastrointestinal stromal tumour (GIST), thyroid cancer, bile duct cancer, endometrial cancer, renal cancer, anaplastic large cell lymphoma, acute myeloid leukaemia (AML), multiple myeloma, melanoma and mesothelioma.

**[0024]** It is envisaged that for the methods of treatment of cancer mentioned herein, the compound of Formula **(I)** will be administered to a mammal, more particularly a human being. Similarly, for the uses of the compound of Formula **(I)** for the treatment of cancer mentioned herein, it is envisaged that the compound of Formula **(I)** will be administered to a mammal, more particularly a human being.

**[0025]** According to a another aspect of the disclosure, there is therefore provided the compound of Formula **(I)** as defined hereinbefore, or a pharmaceutically acceptable salt thereof, for use as a medicament.

**[0026]** According to a further aspect of the disclosure, there is provided the compound of Formula **(I)** as defined hereinbefore, or a pharmaceutically acceptable salt thereof, for use in the treatment of a disease mediated through L858R EGFR mutant and/or T790M EGFR and/or the Exon19 deletion activating mutant. In one embodiment of the invention, said disease mediated through L858R EGFR mutant and/or T790M EGFR mutant and/or the Exon19 deletion activating mutant is cancer.

**[0027]** According to a further aspect of the disclosure, there is provided the use of the compound of Formula **(I)** as defined hereinbefore, or a pharmaceutically acceptable salt thereof, for the manufacture of a medicament for the treatment of a disease mediated through L858R EGFR mutant and/or T790M EGFR mutant and/or the Exon19 deletion activating mutant. In one embodiment of the disclosure, said disease mediated through L858R EGFR

mutant and/or T790M EGFR mutant and/or the Exon19 deletion activating mutant is cancer.

**[0028]** According to a further aspect of the disclosure, there is provided the use of the compound of Formula **(I)** as defined hereinbefore, or a pharmaceutically acceptable salt thereof, for the manufacture of a medicament for the treatment of cancer.

**[0029]** According to a further aspect of the disclosure, there is provided a method of using a compound of Formula **(I)** as defined hereinbefore, or a pharmaceutically acceptable salt thereof, for the treatment of cancer.

**[0030]** According to this aspect of the disclosure there is provided a method for producing an anti-cancer effect in a warm-blooded animal, such as man, in need of such treatment, which comprises administering to said animal an effective amount of the compound of Formula **(I),** or a pharmaceutically acceptable salt thereof, as defined herein.

**[0031]** According to a further aspect of the disclosure, there is provided a method of treating a human suffering from a disease in which inhibition of L858R EGFR mutant and/or T790M EGFR mutant and/or the Exon19 deletion activating mutant is beneficial, comprising the steps of administering to a person in need thereof of a therapeutically effective amount of the compound of Formula **(I)** as defined hereinbefore, or a pharmaceutically acceptable salt thereof. In one embodiment of the disclosure, the disease in which inhibition of L858R EGFR mutant and/or T790M EGFR mutant and/or the Exon19 deletion activating mutant is beneficial is cancer.

**[0032]** In any of the aspects or embodiments mentioned herein where cancer is mentioned in a general sense, said cancer may be selected from ovarian cancer, cervical cancer, colorectal cancer, breast cancer, pancreatic cancer, glioma, glioblastoma, melanoma, prostate cancer, leukaemia, lymphoma, non-Hodgkins lymphoma, gastric cancer, lung cancer, hepatocellular cancer, gastric cancer, gastrointestinal stromal tumour (GIST), thyroid cancer, bile duct cancer, endometrial cancer, renal cancer, anaplastic large cell lymphoma, acute myeloid leukaemia (AML), multiple myeloma, melanoma and mesothelioma.

**[0033]** In any aspect or embodiment of the invention where cancer is mentioned in a general sense the following embodiments may apply:

In one embodiment the cancer is ovarian cancer.

In one embodiment the cancer is cervical cancer.

In one embodiment the cancer is colorectal cancer.

In one embodiment the cancer is breast cancer.

In one embodiment the cancer is pancreatic cancer.

In one embodiment the cancer is glioma.

In one embodiment the cancer is glioblastoma.

In one embodiment the cancer is melanoma.

In one embodiment the cancer is prostate cancer.

In one embodiment the cancer is leukaemia.

In one embodiment the cancer is lymphoma.

In one embodiment the cancer is non-Hodgkins lymphoma.

In one embodiment the cancer is gastric cancer.

In one embodiment the cancer is lung cancer.

In one embodiment the cancer is non-small cell lung cancer.

In one embodiment the cancer is hepatocellular cancer.

In one embodiment the cancer is gastric cancer.

In one embodiment the cancer is gastrointestinal stromal tumour (GIST).

In one embodiment the cancer is thyroid cancer.

In one embodiment the cancer is bile duct cancer.

In one embodiment the cancer is endometrial cancer.

In one embodiment the cancer is renal cancer.

In one embodiment the cancer is anaplastic large cell lymphoma.

In one embodiment the cancer is acute myeloid leukaemia (AML).

In one embodiment the cancer is multiple myeloma.

In one embodiment the cancer is melanoma.

In one embodiment the cancer is mesothelioma.

**[0034]** The anti-cancer treatment described hereinbefore may be applied as a sole therapy or may involve, in addition to the compound of the invention, conventional surgery or radiotherapy or chemotherapy or immunotherapy. Such chemotherapy could be administered concurrently, simultaneously, sequentially or separately to treatment with the compound of the invention and may include one or more of the following categories of anti-tumour agents:-

1. (i) antiproliferative/antineoplastic drugs and combinations thereof, as used in medical

oncology, such as alkylating agents (for example *cis*-platin, oxaliplatin, carboplatin, cyclophosphamide, nitrogen mustard, melphalan, chlorambucil, busulphan, temozolamide and nitrosoureas); antimetabolites (for example gemcitabine and antifolates such as fluoropyrimidines like 5-fluorouracil and tegafur, raltitrexed, methotrexate, cytosine arabinoside, and hydroxyurea); antitumour antibiotics (for example anthracyclines like adriamycin, bleomycin, doxorubicin, daunomycin, epirubicin, idarubicin, mitomycin-C, dactinomycin and mithramycin); antimitotic agents (for example vinca alkaloids like vincristine, vinblastine, vindesine and vinorelbine and taxoids like taxol and taxotere and polokinase inhibitors); and topoisomerase inhibitors (for example epipodophyllotoxins like etoposide and teniposide, amsacrine, topotecan and camptothecin);

2. (ii) cytostatic agents such as antioestrogens (for example tamoxifen, fulvestrant, toremifene, raloxifene, droloxifene and iodoxyfene), antiandrogens (for example bicalutamide, flutamide, nilutamide and cyproterone acetate), LHRH antagonists or LHRH agonists (for example goserelin, leuprorelin and buserelin), progestogens (for example megestrol acetate), aromatase inhibitors (for example as anastrozole, letrozole, vorazole and exemestane) and inhibitors of 5α-reductase such as finasteride;
3. (iii) anti-invasion agents [for example c-Src kinase family inhibitors like 4-(6-chloro-2,3-methylenedioxyanilino)-7-[2-(4-methylpiperazin-1-yl)ethoxy]-5-tetrahydropyran-4-yloxyquinazoline [AZD0530 (saracatinib); WO01/94341], *N*-(2-chloro-6-methylphenyl)-2-{6-[4-(2-hydroxyethyl)piperazin-1-yl]-2-methylpyrimidin-4-ylamino}thiazole-5-carboxamide (dasatinib, BMS-354825; J. Med. Chem., 2004, 47, 6658-6661) and bosutinib (SKI-606), and metalloproteinase inhibitors like marimastat, inhibitors of urokinase plasminogen activator receptor function or antibodies to Heparanase];
4. (iv) inhibitors of growth factor function: for example such inhibitors include growth factor antibodies and growth factor receptor antibodies (for example the anti-erbB2 antibody trastuzumab [Herceptin™], the anti-EGFR antibody panitumumab, the anti-erbB 1 antibody cetuximab [Erbitux, C225] and any growth factor or growth factor receptor antibodies disclosed by Stern et al. Critical reviews in oncology/haematology, 2005, Vol. 54, pp11-29); such inhibitors also include tyrosine kinase inhibitors, for example inhibitors of the epidermal growth factor family (for example EGFR family tyrosine kinase inhibitors such as *N*-(3-chloro-4-fluorophenyl)-7-methoxy-6-(3-morpholinopropoxy)-quinazolin-4-amine (gefitinib, ZD1839), *N*-(3-ethynylphenyl)-6,7-bis(2-methoxyethoxy)quinazolin-4-amine (erlotinib, OSI-774) and 6-acrylamido-*N*-(3-chloro-4-fluorophenyl)-7-(3-morpholinopropoxy)-quinazolin-4-amine (CI 1033), erbB2 tyrosine kinase inhibitors such as lapatinib); inhibitors of the hepatocyte growth factor family; inhibitors of the insulin growth factor family; inhibitors of the platelet-derived growth factor family such as imatinib and/or nilotinib (AMN107); inhibitors of serine/threonine kinases (for example Ras/Raf signalling inhibitors such as farnesyl transferase inhibitors, for example sorafenib (BAY 43-9006), tipifarnib (R115777) and lonafarnib (SCH66336)), inhibitors of cell signalling through MEK and/or AKT kinases, c-kit inhibitors, abl kinase inhibitors, PI3 kinase inhibitors, Plt3 kinase inhibitors, CSF-1R kinase inhibitors, IGF receptor (insulinlike growth factor) kinase inhibitors; aurora kinase inhibitors (for example AZD1152, PH739358, VX-680, MLN8054, R763, MP235, MP529, VX-528 AND

AX39459) and cyclin dependent kinase inhibitors such as CDK2 and/or CDK4 inhibitors;

5. (v) antiangiogenic agents such as those which inhibit the effects of vascular endothelial growth factor, [for example the anti-vascular endothelial cell growth factor antibody bevacizumab (Avastin™) and for example, a VEGF receptor tyrosine kinase inhibitor such as vandetanib (ZD6474), vatalanib (PTK787), sunitinib (SU11248), axitinib (AG-013736), pazopanib (GW 786034) and 4-(4-fluoro-2-methylindol-5-yloxy)-6-methoxy-7-(3-pyrrolidin-1-ylpropoxy)quinazoline (AZD2171; Example 240 within WO 00/47212), compounds such as those disclosed in WO97/22596, WO97/30035, WO97/32856 and WO98/13354 and compounds that work by other mechanisms (for example linomide, inhibitors of integrin αvβ3 function and angiostatin)];
6. (vi) vascular damaging agents such as Combretastatin A4 and compounds disclosed in WO99/02166, WO00/40529, WO00/41669, WO01/92224, WO02/04434 and WO02/08213;
7. (vii) an endothelin receptor antagonist, for example zibotentan (ZD4054) or atrasentan;
8. (viii) antisense therapies, for example those which are directed to the targets listed above, such as ISIS 2503, an anti-ras antisense;
9. (ix) gene therapy approaches, including for example approaches to replace aberrant genes such as aberrant p53 or aberrant BRCA1 or BRCA2, GDEPT (gene-directed enzyme pro-drug therapy) approaches such as those using cytosine deaminase, thymidine kinase or a bacterial nitroreductase enzyme and approaches to increase patient tolerance to chemotherapy or radiotherapy such as multi-drug resistance gene therapy; and
10. (x) immunotherapy approaches, including for example *ex-vivo* and *in-vivo* approaches to increase the immunogenicity of patient tumour cells, such as transfection with cytokines such as interleukin 2, interleukin 4 or granulocyte-macrophage colony stimulating factor, approaches to decrease T-cell anergy, approaches using transfected immune cells such as cytokine-transfected dendritic cells, approaches using cytokine-transfected tumour cell lines, approaches using anti-idiotypic antibodies, approaches to decrease the function of immune suppressive cells such as regulatory T cells, myeloid-derived suppressor cells or IDO (indoleamine 2,3,-deoxygenase)-expressing dendritic cells, and approaches using cancer vaccines consisting of proteins or peptides derived from tumour-associated antigens such as NY-ESO-1, MAGE-3, WT1 or Her2/neu.

**[0035]** Therefore, in a further aspect of the disclosure there is provided a pharmaceutical product comprising the compound of Formula **(I)** as defined hereinbefore, and an additional anti-tumour substance, as defined hereinbefore, for the conjoint treatment of cancer.

**[0036]** In such an aspect of the disclosure there is provided a pharmaceutical product comprising the compound of Formula **(I),** or a pharmaceutically acceptable salt thereof, as defined herein, and an additional anti-tumour substance, as defined hereinbefore, for the conjoint treatment of cancer.

**[0037]** Herein, where the term "conjoint treatment" is used in reference to a combination treatment, it is to be understood that this may refer to simultaneous, separate or sequential administration. Refrerenes to "conjoint administration" should be constued similarly. In one aspect of the disclosure "conjoint treatment" refers to simultaneous administration. In another aspect of the disclosure "conjoint treatment" refers to separate administration. In a further aspect of the disclosure "conjoint treatment" refers to sequential administration. Where the administration is sequential or separate, the delay in administering the second component should not be such as to lose the benefit of the effect arising from use of the combination. Therefore, in one embodiment of the disclosure sequential treatment involves administration of each component of the combination within a period of 11 days. In another embodiment of the disclosure this period is 10 days. In another embodiment of the disclosure this period is 9 days. In another embodiment of the disclosure this period is 8 days. In another embodiment of the disclosure this period is 7 days. In another embodiment of the disclosure this period is within 6 days. In another embodiment of the disclosure this period is within 5 days. In another embodiment of the disclosure this period is within 4 days. In another embodiment of the disclosure this period is within 3 days. In another embodiment of the disclosure this period is within 2 days. In another embodiment of the disclosure this period is within 24 hours. In another embodiment of the disclosure this period is within 12 hours.

**[0038]** Therefore, in one embodiment of the disclosure there is provided the use of a compound of Formula **(I),** or a pharmaceutically acceptable salt thereof, as defined herein, and an additional anti-tumour substance for the conjoint treatment of cancer.

**[0039]** In one embodiment of the disclosure there is provided the use of a compound of Formula **(I),** or a pharmaceutically acceptable salt thereof, as defined herein, and an additional anti-tumour substance for the simultaneous, separate or sequential treatment of cancer.

**[0040]** In one embodiment of the disclosure there is provided a method of producing an anti-cancer effect in a warm-blooded animal, such as man, who is in need of such treatment, which comprises administering to said mammal a compound of Formula **(I),** or a pharmaceutically acceptable salt thereof, and conjointly administering an additional antitumour substance to said mammal, wherein the amounts of the compound of Formula **(I),** or pharmaceutically acceptable salt thereof, and the additional anti-tumour substance are jointly effective in producing an anti-cancer effect.

**[0041]** In one embodiment of the disclosure there is provided a method of producing an anti-cancer effect in a warm-blooded animal, such as man, who is in need of such treatment, which comprises administering to said mammal a compound of Formula **(I),** or a pharmaceutically acceptable salt thereof, and simultaneously, separately or sequentially administering an additional anti-tumour substance to said mammal, wherein the amounts of the compound of Formula **(I),** or pharmaceutically acceptable salt thereof, and the additional anti-tumour substance are jointly effective in producing an anti-cancer effect.

**[0042]** In the formulation of drug compositions, it is important for the drug substance to be in a

form in which it can be conveniently handled and processed. This is of importance, not only from the point of view of obtaining a commercially viable manufacturing process, but also from the point of view of subsequent manufacture of pharmaceutical formulations (e.g. oral dosage forms such as tablets) comprising the active compound.

**[0043]** The different physical properties of the crystalline forms with respect to each other and with respect to the non-crystalline state may influence markedly the chemical and pharmaceutical processing of a compound, particularly when the compound is prepared or used on an industrial scale.

**[0044]** Further, in the manufacture of oral drug compositions, it is important that a reliable and reproducible plasma concentration profile of drug is provided following administration to a patient. Inter-patient variability in the absorption profile of a drug within the stomach, intestine or bloodstream can have an effect on drug safety and efficacy.

**[0045]** Chemical stability, solid state stability and "shelf life" of the active ingredients are also very important factors. The drug substance, and compositions containing it, should be capable of being effectively stored over appreciable periods of time, without exhibiting a significant change in the active component's physico-chemical characteristics (e.g. its chemical composition, density, hygroscopicity and solubility).

**[0046]** Moreover, it is also important to be able to provide drug in a form which is as chemically pure as possible.

**[0047]** Amorphous materials may present problems in this regard. For example, such materials are typically difficult to handle and to formulate, provide for unreliable solubility, and are often found to be unstable and chemically impure.

**[0048]** The skilled person will appreciate that, if a drug can be readily obtained in a stable crystalline form, the above problems may be solved.

**[0049]** Thus, in the manufacture of commercially viable, and pharmaceutically acceptable, drug compositions, it is important, wherever possible, to provide drug in a crystalline, and stable, form.

**[0050]** It is to be noted, however, that this goal is not always achievable. Indeed, typically, it is not possible to predict, from molecular structure alone, what the crystallisation behaviour of a compound, either as such or in the form of a salt, will be. This can only be determined empirically.

**[0051]** In a further aspect of the invention, certain compounds and salts thereof may be prepared in crystalline forms. These crystalline forms may be characterised as being a particular polymorphic form. When it is stated that the present invention relates to a crystalline form, the degree of crystallinity is conveniently greater than about 60%, more conveniently

greater than about 80%, preferably greater than about 90% and more preferably greater than about 95%. Most preferably the degree of crystallinity is greater than about 98%.

**[0052]** The specific solid forms described herein provide X-ray powder diffraction patterns substantially the same as the X-ray powder diffraction patterns shown in the Figures and have the various 2-theta values as shown in the Tables included herein. It will be understood that the 2-theta values of a X-ray powder diffraction pattern may vary slightly from one machine to another or from one sample to another, and so the values quoted are not to be construed as absolute.

**[0053]** It is known that an X-ray powder diffraction pattern may be obtained which has one or more measurement errors depending on measurement conditions (such as equipment or machine used). In particular, it is generally known that intensities in an X-ray powder diffraction pattern may fluctuate depending on measurement conditions. Therefore it should be understood that the solid forms of the present invention are not limited to the crystals that provide X-ray powder diffraction patterns that are identical to the X-ray powder diffraction pattern shown in the Figures, and any crystals providing X-ray powder diffraction patterns substantially the same as those shown in the Figures fall within the scope of the present invention. A person skilled in the art of X-ray powder diffraction is able to judge the substantial identity of X-ray powder diffraction patterns.

**[0054]** Persons skilled in the art of X-ray powder diffraction will realise that the relative intensity of peaks can be affected by, for example, grains above 30µm in size and nonunitary aspect ratios, which may affect analysis of samples. The skilled person will also realise that the position of reflections can be affected by the precise height at which the sample sits in the diffractometer and the zero calibration of the diffractometer. The surface planarity of the sample may also have a small effect. Hence the diffraction pattern data presented are not to be taken as absolute values. (Jenkins, R & Snyder, R.L. 'Introduction to X-Ray Powder Diffractometry' John Wiley & Sons 1996; Bunn, C.W. (1948), Chemical Crystallography, Clarendon Press, London; Klug, H. P. & Alexander, L. E. (1974), X-Ray Diffraction Procedures).

**[0055]** Generally, a measurement error of a diffraction angle in an X-ray powder diffractogram is approximately plus or minus 0.2° 2-theta, and such degree of a measurement error should be taken into account when considering the X-ray powder diffraction pattern in the Figures and when reading data contained in the Tables included herein. Furthermore, it should be understood that intensities might fluctuate depending on experimental conditions and sample preparation (preferred orientation).

**[0056]** In this specification *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide is referred to as **"Compound X".** The initially produced **Compound X** was found to be an amorphous solid. Several useful crystalline polymorphic forms have subsequently been produced using the conditions described hereinafter in the experimental section. In all of the embodiments relating to solid forms recited herein, the peaks of the X-ray diffraction patterns are measured using CuKa

radiation.

**Polymorphic Form A of Compound X (Reference)**

**[0057]** Disclosed herein is polymorphic Form A of **Compound** X. This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 7.8 and 21.8.

**[0058]** Polymorphic Form A of **Compound X** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 1.

**[0059]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are 7.8 (100%), 21.8 (73.4%), 13.3 (59.4%), 6.6 (49.5%), 23.9 (40.5%), 9.6 (38.1%), 14.5 (35.3%), 15.6 (33.2%), 22.7 (31.2%) and 19.1 (29.8%).

**[0060]** According to the present disclosure there is provided the polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 7.8°.

**[0061]** According to the present disclosure there is provided the polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 21.8°.

**[0062]** According to the present disclosure there is provided the polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 7.8° and 21.8°.

**[0063]** According to the present disclosure there is provided the polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 7.8, 21.8, 13.3, 6.6, 23.9, 9.6, 14.5, 15.6, 22.7 and 19.1°.

**[0064]** According to the present disclosure there is provided polymorphic Form A of **Compound X** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 1.

**[0065]** According to the present disclosure there is provided polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 7.8° plus or minus 0.2° 2-theta.

**[0066]** According to the present disclosure there is provided a polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 21.8° plus or minus 0.2° 2-theta.

**[0067]** According to the present discloure there is provided the polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 7.8° and 21.8° wherein said values may be plus or minus 0.2° 2-theta.

**[0068]** According to the present disclosure there is provided a polymorphic Form A of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 7.8, 21.8, 13.3, 6.6, 23.9, 9.6, 14.5, 15.6, 22.7 and 19.1° wherein said values may be plus or minus 0.2° 2-theta.

**Polymorphic Form B of Compound X (Reference)**

**[0069]** Disclosed herein is polymorphic Form B of **Compound X.** This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 9.3 and 23.4.

**[0070]** Polymorphic Form B of **Compound X** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 3.

**[0071]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are 9.3 (100%), 23.4 (75.0%), 10.5 (63.6%), 17.7 (54.3%), 21.0 (48.1%), 16.1 (46.4%), 26.1 (44.2%), 18.6 (41.8%), 26.7 (32.2%) and 20.6 (30.9%).

**[0072]** According to the present disclosure there is provided the polymorphic Form B of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 9.3°.

**[0073]** According to the present disclosure there is provided the polymorphic Form B of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 23.4°.

**[0074]** According to the present disclosure there is provided the polymorphic Form B of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 9.3° and 23.4°.

**[0075]** According to the present disclosure there is provided the polymorphic Form B of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 9.3, 23.4, 10.5, 17.7, 21.0, 16.1, 26.1, 18.6, 26.7 and 20.6°.

**[0076]** According to the present disclosure there is provided polymorphic Form B of **Compound X** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 3.

**[0077]** According to the present disclosure there is provided polymorphic Form B of

**Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 9.3° plus or minus 0.2° 2-theta.

**[0078]** According to the present disclosure there is provided the polymorphic Form B of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 23.4° plus or minus 0.2° 2-theta.

**[0079]** According to the present disclosure there is provided the polymorphic Form B of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 9.3° and 23.4° wherein said values may be plus or minus 0.2° 2-theta.

**[0080]** According to the present disclosure there is provided the polymorphic Form B of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 9.3, 23.4, 10.5, 17.7, 21.0, 16.1, 26.1, 18.6, 26.7 and 20.6° wherein said values may be plus or minus 0.2° 2-theta.

**Polymorphic Form C of Compound X (Reference)**

**[0081]** Disclosed herein is polymorphic Form C of **Compound** X. This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 6.0 and 11.3.

**[0082]** Polymorphic Form C of **Compound X** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 5.

**[0083]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are 6.0 (100%), 11.3 (58.2%), 7.5 (40.5%), 10.3 (21.9%), 12.0 (20.1%), 24.9 (19.4%), 13.0 (16.9%), 14.5 (13.5%), 16.5 (13.5%) and 18.3 (11.8%).

**[0084]** According to the present disclosure there is provided the polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 6.0°.

**[0085]** According to the present disclosure there is provided the polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 11.3°.

**[0086]** According to the present disclosure there is provided the polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 6.0° and 11.3°.

**[0087]** According to the present disclosure there is provided the polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at about 2-

theta = 6.0, 11.3, 7.5, 10.3, 12.0, 24.9, 13.0, 14.5, 16.5, and 18.3°.

**[0088]** According to the present disclosure there is provided polymorphic Form C of **Compound X** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 5.

**[0089]** According to the present disclosure there is provided polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 6.0° plus or minus 0.2° 2-theta.

**[0090]** According to the present disclosure there is provided the polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 11.3° plus or minus 0.2° 2-theta.

**[0091]** According to the present disclosure there is provided the polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 6.0° and 11.3° wherein said values may be plus or minus 0.2° 2-theta.

**[0092]** According to the present disclosure there is provided the polymorphic Form C of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 6.0, 11.3, 7.5, 10.3, 12.0, 24.9, 13.0, 14.5, 16.5, and 18.3° wherein said values may be plus or minus 0.2° 2-theta.

**Polymorphic Form D of Compound X (Reference)**

**[0093]** Disclosed herein is polymorphic Form D of **Compound X** which is believed to be a monohydrate crystalline form. This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 9.3 and 10.5.

**[0094]** Polymorphic Form D of **Compound X** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 7.

**[0095]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are 9.3 (100%), 10.5 (90.6%), 16.1 (75.8%), 26.1 (75.2%), 21.0 (70.9%), 20.6 (56.9%), 16.8 (56.5%), 17.7 (53.3%), 14.7 (41.3%) and9.7 (38.3%).

**[0096]** According to the present disclosure there is provided the polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 9.3°.

**[0097]** According to the present disclosure there is provided the polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 10.5°.

**[0098]** According to the present disclosure there is provided the polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 9.3° and 10.5°.

**[0099]** According to the present disclosure there is provided the polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 9.3, 10.5, 16.1, 26.1, 21.0, 20.6, 16.8, 17.7, 14.7, and 9.7°.

**[0100]** According to the present disclosure there is provided polymorphic Form D of **Compound X** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 7.

**[0101]** According to the present disclosure there is provided polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 9.3° plus or minus 0.2° 2-theta.

**[0102]** According to the present disclosure there is provided the polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 10.5° plus or minus 0.2° 2-theta.

**[0103]** According to the present disclosure there is provided the polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 9.3° and 10.5° wherein said values may be plus or minus 0.2° 2-theta.

**[0104]** According to the present disclosure there is provided the polymorphic Form D of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 9.3, 10.5, 16.1, 26.1, 21.0, 20.6, 16.8, 17.7, 14.7, and 9.7° wherein said values may be plus or minus 0.2° 2-theta.

**Polymorphic Form E of Compound X (Reference)**

**[0105]** In a further aspect of the disclosure there is provided polymorphic Form E of **Compound** X which is believed to be a 1.25 stoichiometry hydrated form of **Compound** X. This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 9.2 and 22.9.

**[0106]** Polymorphic Form E of **Compound X** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 10.

**[0107]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are: 9.2 (100%), 22.9 (84.0%), 14.6 (80.3%), 12.7 (77.8%), 16.5 (66.4%), 26.9 (60.3%), 9.7 (95.6%), 14.0 (52.3%), 10.4 (49.9%) and 19.5 (48.3%).

**[0108]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 9.2°.

**[0109]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 22.9°.

**[0110]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 9.2° and 22.9°.

**[0111]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 9.2, 22.9, 14.6, 12.7, 16.5, 26.9, 9.7, 14.0, 10.4 and 19.5°.

**[0112]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 10.

**[0113]** According to the present disclosure there is provided polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 9.2° plus or minus 0.2° 2-theta.

**[0114]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 22.9° plus or minus 0.2° 2-theta.

**[0115]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 9.2° and 22.9° wherein said values may be plus or minus 0.2° 2-theta.

**[0116]** According to the present disclosure there is provided the polymorphic Form E of **Compound X** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 9.2, 22.9, 14.6, 12.7, 16.5, 26.9, 9.7, 14.0, 10.4, and 19.5° wherein said values may be plus or minus 0.2° 2-theta.

**Polymorphic Form F of Compound X (Reference)**

**[0117]** Disclosed herein is polymorphic Form F of **Compound X** which is believed to be a 0.25 stoichiometry hydrated form of **Compound X.** This polymorphic form may be characterised in

that it provides at least one of the following 2θ values measured using CuKa radiation: 18.7 and 8.9.

**[0118]** Polymorphic Form F of **Compound X** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 13.

**[0119]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are: 18.7 (100%), 8.9 (87.7%), 15.1 (80.3%), 25.4 (74.6%), 14.5 (72.3%), 22.9 (69.6%), 9.9 (51.1%), 28.2 (42.0%), 8.2 (24.2%) and 11.9 (22.3%).

**[0120]** According to the present disclosure there is provided the polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 18.7°.

**[0121]** According to the present disclosure there is provided the polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 8.9°.

**[0122]** According to the present disclosure there is provided the polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 18.7° and 8.9°.

**[0123]** According to the present disclosure there is provided the polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 18.7, 8.9, 15.1, 25.4, 14.5, 22.9, 9.9, 28.2, 8.2 and 11.9°.

**[0124]** According to the present disclosure there is provided polymorphic Form F of **Compound X** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 13.

**[0125]** According to the present disclosure there is provided polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 18.7° plus or minus 0.2° 2-theta.

**[0126]** According to the present disclosure there is provided the polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 8.9° plus or minus 0.2° 2-theta.

**[0127]** According to the present disclosure there is provided the polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 18.7° and 8.9° wherein said values may be plus or minus 0.2° 2-theta.

**[0128]** According to the present disclosure there is provided the polymorphic Form F of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta =

18.7, 8.9, 15.1, 25.4, 14.5, 22.9, 9.9, 28.2, 8.2 and 11.9° wherein said values may be plus or minus 0.2° 2-theta.

**Polymorphic Form K of Compound X (Reference)**

**[0129]** Disclosed herein is polymorphic Form K of **Compound** X. This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 8.4 and 9.7.

**[0130]** Polymorphic Form F of **Compound X** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 16.

**[0131]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are: 8.4 (100%), 9.7 (37.7%), 12.2 (32.4%), 15.1 (25.2%), 24.7 (20.7%), 9.0 (16.8%), 21.9 (13.9%), 19.5 (13.9%), 24.2 (13.8%) and 18.3 (11.8%).

**[0132]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 8.4°.

**[0133]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 9.7°.

**[0134]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 8.4° and 9.7°.

**[0135]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 8.4, 9.7, 12.2, 15.1, 24.7, 9.0, 21.9, 19.5, 24.2 and 18.3°.

**[0136]** According to the present disclosure there is provided the polymorphic Form K of **Compound X** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 16.

**[0137]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 8.4° plus or minus 0.2° 2-theta.

**[0138]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 9.7° plus or minus 0.2° 2-theta.

**[0139]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 8.4° and 9.7° wherein said values may be plus or minus 0.2° 2-theta.

**[0140]** According to the present disclosure there is provided the polymorphic Form K of **Compound X,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 8.4, 9.7, 12.2, 15.1, 24.7, 9.0, 21.9, 19.5, 24.2 and 18.3° wherein said values may be plus or minus 0.2° 2-theta.

**[0141]** In this specification the mesylate salt of *N*-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide is referred to as **"Mesylate Salt Y".**

**Polymorphic Form A of Mesylate Salt Y (Reference)**

**[0142]** Disclosed herein is a polymorphic Form A of Mesylate Salt Y. This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 5.6 and 6.5.

**[0143]** Polymorphic Form A of **Mesylate Salt Y** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 18.

**[0144]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are: 5.6 (100%), 6.5 (66.7%), 10.2 (97.2%), 21.0 (96.2%), 13.5 (91.7%), 22.7 (89.6%), 19.3 (80.6%), 27.3 (75.7%), 15.7 (71.2%) and 19.9 (66.7%).

**[0145]** According to the present disclosure there is provided the polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 5.6°.

**[0146]** According to the present disclosure there is provided the polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 6.5°.

**[0147]** According to the present disclosure there is provided the polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 5.6° and 6.5°.

**[0148]** According to the present disclosure there is provided the polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 5.6, 6.5, 10.2, 21.0, 13.5, 22.7, 19.3, 27.3, 15.7 and 19.9°.

**[0149]** According to the present disclosure there is provided polymorphic Form A of **Mesylate Salt** Y which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 18.

**[0150]** According to the present disclosure there is provided polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 5.6° plus or minus 0.2° 2-theta.

**[0151]** According to the present disclosure there is provided the polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 6.5° plus or minus 0.2° 2-theta.

**[0152]** According to the present disclosure there is provided the polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 5.6° and 6.5° wherein said values may be plus or minus 0.2° 2-theta.

**[0153]** According to the present disclosure there is provided the polymorphic Form A of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 5.6, 6.5, 10.2, 21.0, 13.5, 22.7, 19.3, 27.3, 15.7 and 19.9° wherein said values may be plus or minus 0.2° 2-theta.

**Polymorphic Form B of Mesylate Salt Y**

**[0154]** In a further aspect of the invention there is provided polymorphic Form B of **Mesylate Salt Y.** This polymorphic form may be characterised in that it provides at least one of the following 2θ values measured using CuKa radiation: 7.2 and 8.6.

**[0155]** Polymorphic Form B of **Mesylate Salt Y** is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure 20.

**[0156]** Ten X-Ray powder diffraction peaks for this polymorphic form [Angle 2-theta (2θ), Intensity (%)] are: 7.2 (50.2%), 8.6 (55.2%), 15.3 (100%), 10.4 (92.6%), 25.7 (74.0%), 26.1 (63.9%), 16.4 (55.2%), 9.5 (47.5%), 22.1 (46.9%) and 18.8 (47.7%).

**[0157]** According to the present disclosure there is provided the polymorphic Form B of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 7.2°.

**[0158]** According to the present disclosure there is provided the polymorphic Form B of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 8.6°.

**[0159]** According to the present disclosure there is provided the polymorphic Form B of

**Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 7.2° and 8.6°.

**[0160]** According to the present disclosure there is provided the polymorphic Form B of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 7.2, 8.6, 15.3, 10.4, 25.7, 26.1, 16.4, 9.5, 22.1 and 18.8°.

**[0161]** According to the present invention there is provided polymorphic Form B of **Mesylate Salt Y** which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure 20.

**[0162]** According to the present invention there is provided polymorphic Form B of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 7.2° plus or minus 0.2° 2-theta.

**[0163]** According to the present invention there is provided the polymorphic Form B of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 8.6° plus or minus 0.2° 2-theta.

**[0164]** According to the present invention there is provided the polymorphic Form B of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 7.2° and 8.6° wherein said values may be plus or minus 0.2° 2-theta.

**[0165]** According to the present invention there is provided the polymorphic Form B of **Mesylate Salt Y,** which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 7.2, 8.6, 15.3, 10.4, 25.7, 26.1, 16.4, 9.5, 22.1 and 18.8° wherein said values may be plus or minus 0.2° 2-theta.

**List of Figures**

**[0166]** All figures relate to solid forms of the compound: *N*-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide **("Compound X"**) or its mesylate salt where indicated **("Mesylate Salt Y").**

Figure 1:
X-Ray Powder Diffraction Pattern - Form A
Figure 2:
DSC Thermogram - Form A
Figure 3:
X-Ray Powder Diffraction Pattern - Form B
Figure 4:
DSC Thermogram - Form B

Figure 5:
X-Ray Powder Diffraction Pattern - Form C
Figure 6:
DSC Thermogram - Form C
Figure 7:
X-Ray Powder Diffraction Pattern - Form D (Monohydrate)
Figure 8:
DSC Thermogram - Form D Monohydrate
Figure 9:
TGA Thermogram - Form D Monohydrate
Figure 10:
X-Ray Powder Diffraction Pattern - Form E (Hydrated Form)
Figure 11:
DSC Thermogram - Form E (Hydrated Form)
Figure 12:
TGA Thermogram - Form E (Hydrated form)
Figure 13:
X-Ray Powder Diffraction - Form F (Hydrated Form)
Figure 14:
DSC Thermogram - Form F (Hydrated Form)
Figure 15:
TGA Thermogram - Form F (Hydrated form)
Figure 16:
X-Ray Powder Diffraction Pattern - Form K
Figure 17:
DSC Thermogram - Form K
Figure 18:
X-Ray Powder Diffraction Pattern - Mesylate salt Form A
Figure 19:
DSC Thermogram - Mesylate salt Form A
Figure 20:
X-Ray Powder Diffraction Pattern - Mesylate salt Form B
Figure 21:
DSC Thermogram - Mesylate salt Form B

**Chemical synthesis and biological assay procedures**

**[0167]** The following abbreviations may be used: Abbreviations: THF = tetrahydrofuran; DIPEA = diisopropylethylamine; sat. = saturated aqueous solution; FCC = flash column chroatography using silica; TFA = trifluoroacetic acid; r.t. = room temperature; DMF = *N,N*-dimethylformamide; DMSO = dimethylsulfoxide; DMA = *N,N*-dimethylacetamide; EtOAc = ethyl acetate; h. = hour(s);

Proton NMR: ($^1$H NMR) was determined using deuterated dimethylsulfoxide at 400 or 500MHz at around 20-30°C, unless otherwise stated. Standard NMR abbreviations are used, (s = singlet; d = doublet; dd = double of doublets; t = triplet; q = quartet; p = pentet; m = multiplet; br = broad; etc.). Where iron was mentioned as a reagent, it was iron powder, 325 mesh and hydrogen reduced. Quoted assay values (μM) for a given Example are ICso values. X-Ray Powder Diffraction (XRPD) was carried out using a Bruker D4 instrument. The X-ray powder diffractogram was determined by mounting a sample of the crystalline material on a Bruker single silicon crystal (SSC) wafer mount and spreading out the sample into a thin layer with the aid of a microscope slide. The sample was spun at 30 revolutions per minute (to improve counting statistics) and irradiated with X-rays generated by a copper long-fine focus tube operated at 40kV and 40mA with a wavelength of 1.5418 angstroms (CuKa radiation). The collimated X-ray source was passed through an automatic variable divergence slit set at V20 and the reflected radiation directed through a 5.89mm antiscatter slit and a 9.55mm detector slit. The sample was exposed for 0.03 seconds per 0.00570° 2-theta increment (continuous scan mode) over the range 2 degrees to 40 degrees 2-theta in theta-theta mode. The running time was 3 minutes and 36 seconds. The instrument was equipped with a Position sensitive detector (Lynxeye). Control and data capture was by means of a Dell Optiplex 686 NT 4.0 Workstation operating with Diffrac+ software. Differential Scanning Calorimetry (DSC) was carried out using a "TA Instruments Q1000 differential scanning calorimeter. Typically less than 5 mg of material contained in a standard aluminium pan fitted with a lid was heated over the temperature range 25°C to 300°C at a constant heating rate of 10°C per minute. A purge gas using nitrogen was used - flow rate 50mL per minute. Any crystal form that provides a XRPD diffractogram or DSC thermogram substantially identical to those disclosed herein fall within the scope of the present inventions. One skilled in the art will have the ability to determine substantial identities of diffractograms and thermograms.

**Assay 1: Exon19 deletion EGFR (Activating Single Mutant) cellular phosphorylation assay**

**[0168]** The human lung cell line PC9 (Exon 19 deletion EGFR) were obtained from the American type Culture Collection. PC9 were maintained in RPMI 1640, containing 10% fetal calf serum and 2mM glutamine. Cells were grown in a humidified incubator at 37°C with 5% $CO_2$. Assays to measure cellular phosphorylation of endogenous p-EGFR in cell lysates were carried out according to the protocol described in the R&D Systems DuoSet IC Human Phospho-EGF R ELISA (R&D Systems catalogue number #DYC1095). 40μL of cells were seeded (10000 cells/well) in growth medium in Corning black, clearbottomed 384-well plates and incubated at 37°C with 5% $CO_2$ overnight. Cells were acoustically dosed using an Echo 555, with compounds serially diluted in 100% DMSO. Plates were incubated for a further 2h, then following aspiration of medium, 40μL 1x lysis buffer was added to each well. Greiner black high bind 384-well plates were coated with capture antibody and then blocked with 3% BSA. Following removal of block, 15μL of lysate were transferred to the Greiner black high bind 384-well plates and incubated for 2 hours. Following aspiration and washing of the plates with PBS,

20µL of detection antibody were added and incubated for 2 hours. Following aspiration and washing of the plates with PBS, 20µL of QuantaBlu fluorogenic peroxidase substrate (Thermo Fisher Scientific catalogue number 15169) were added and incubated for 1 hour. 20µL QuantaBlu stop solution were added to plates and fluorescence read on an Envision plate reader using Excitation 352nm wavelength and emission 460nm wavelength. The data obtained with each compound was exported into a suitable software package (such as Origin) to perform curve fitting analysis. From this data an ICso value was determined by calculation of the concentration of compound that is required to give a 50% effect.

**Assay 2: L858R/T790M EGFR (Double Mutant) Cellular phosphorylation assay**

**[0169]** The human lung cell lines NCI-H1975 were obtained from the American type Culture Collection. NCI-H1975 were maintained in RPMI 1640, containing 10% fetal calf serum and 2mM glutamine. Cells were grown in a humidified incubator at 37°C with 5% $CO_2$. Assays to measure cellular phosphorylation of endogenous p-EGFR in cell lysates were carried out according to the protocol described in the R&D Systems DuoSet IC Human Phospho-EGF R ELISA (R&D Systems catalogue number #DYC1095).

**[0170]** 40µL of cells were seeded (10000 cells/well) in growth medium in Corning black, clearbottomed 384-well plates and incubated at 37°C with 5% $CO_2$ overnight. Cells were acoustically dosed using an Echo 555, with compounds serially diluted in 100% DMSO. Plates were incubated for a further 2h and following aspiration of medium, 40µL 1x lysis buffer was added to each well. Greiner black high bind 384-well plates were coated with capture antibody and then blocked with 3% BSA. Following removal of block, 15µL of lysate were transferred to the Greiner black high bind 384-well plates and incubated for 2 hours. Following aspiration and washing of the plates with PBS, 20µL of detection antibody were added and incubated for 2 hours. Following aspiration and washing of the plates with PBS, 20µL of QuantaBlu fluorogenic peroxidase substrate (Thermo Fisher Scientific catalogue number 15169) were added and incubated for 1 hour. 20µL QuantaBlu stop solution were added to plates and fluorescence read on an Envision plate reader using Excitation 352nm wavelength and emission 460nm wavelength. The data obtained with each compound was exported into a suitable software package (such as Origin) to perform curve fitting analysis. From this data an $IC_{50}$ value was determined by calculation of the concentration of compound that is required to give a 50% effect.

**Assay 3: Wild-type EGFR cellular phosphorylation assay**

**[0171]** The human colon cell line LoVo were obtained from the American type Culture Collection. LoVo were maintained in RPMI 1640, containing 3% stripped fetal calf serum and 2mM glutamine. Cells were grown in a humidified incubator at 37°C with 5% $CO_2$. Assays to measure cellular phosphorylation of endogenous p-EGFR in cell lysates were carried out

according to the protocol described in the R&D Systems DuoSet IC Human Phospho-EGF R ELISA (R&D Systems catalogue number #DYC1095).

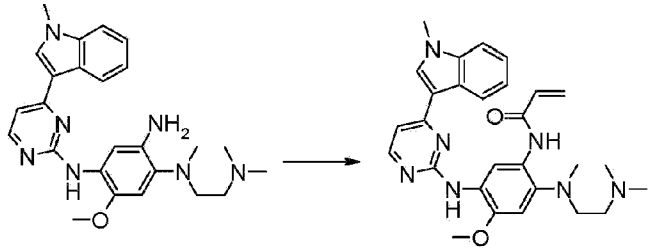
**[0172]** 40µL of cells were seeded (15000 cells/well) in growth medium in Corning black, clearbottomed 384-well plates and incubated at 37°C with 5% $CO_2$ overnight. Cells were acoustically dosed using an Echo 555, with compounds serially diluted in 100% DMSO. Plates were incubated for a further 2h then stimulated with 100ng/ml for 10 minutes and following aspiration of medium, 40µL 1x lysis buffer was added to each well. Greiner black high bind 384-well plates were coated with capture antibody and then blocked with 3% BSA. Following removal of block, 15µL of lysate were transferred to the Greiner black high bind 384-well plates and incubated for 2 hours. Following aspiration and washing of the plates with PBS, 20µL of detection antibody were added and incubated for 2 hours. Following aspiration and washing of the plates with PBS, 20µL of QuantaBlu fluorogenic peroxidase substrate (Thermo Fisher Scientific catalogue number 15169) were added and incubated for 1 hour. 20µL QuantaBlu stop solution were added to plates and fluorescence read on an Envision plate reader using Excitation 352nm wavelength and emission 460nm wavelength. The data obtained with each compound was exported into a suitable software package (such as Origin) to perform curve fitting analysis. From this data an $IC_{50}$ value was determined by calculation of the concentration of compound that is required to give a 50% effect.

**[0173]** The assay data (µM) for the Examples of this application are shown in the table below. While assay data is stated with a certain number of significant figures, this should not be taken as a representation that the data has been determined to be accurate to that number of significant figures.

| Ex. No. | Assay 1 | Assay 2 | Assay 3 |
|---|---|---|---|
| 28 | 0.01292 | 0.01144 | 0.4938 |
| 28A | 0.01975 | 0.01271 | 1.443 |

**Example 28: *N*-(2-{2-Dimethylaminoethyl-methylaminol-4-methoxy-5-{[4-(1methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide**

**[0174]**

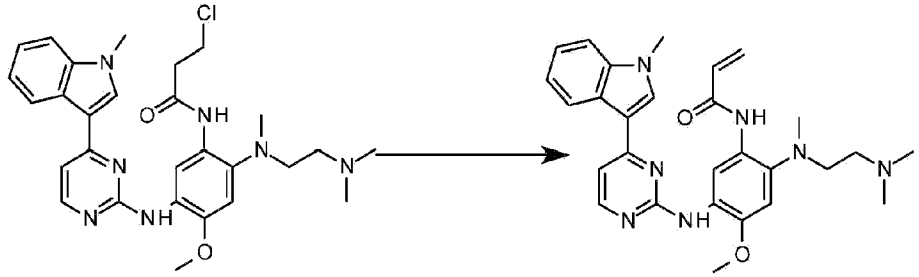


**[0175]** A solution of acryloyl chloride (34.5 mg, 0.38 mmol) in $CH_2Cl_2$ (1 mL) was added

dropwise to a stirred mixture of $N^1$-(2-dimethylaminoethyl)-5-methoxy-$N^1$-methyl-$N^4$-[4-(1-methylindol-3-yl)pyrimidin-2-yl]benzene-1,2,4-triamine **(Intermediate 100,** 170 mg, 0.38 mmol) and DIPEA (0.073 mL, 0.42 mmol) in $CH_2Cl_2$ (5 mL), which was cooled in an ice/water bath. The mixture was stirred for 1.5h and then diluted with $CH_2Cl_2$ (25 mL) and washed with sat.$NaHCO_3$ (50 mL). The aqueous washes were extracted with $CH_2Cl_2$ (2 × 25 mL). The combined organic solutions were dried ($MgSO_4$) and concentrated *in vacuo.* Purification by FCC, eluting with 0-4% 7N methanolic ammonia in $CH_2Cl_2$ gave the title compound (75 mg, 39%) as a cream solid after trituration with diethyl ether; $^1$H NMR: 2.21 (6H, s), 2.29 (2H, t), 2.72 (3H, s), 2.89 (2H, t), 3.86 (3H, s), 3.92 (3H, s), 5.77 (1H, dd), 6.27 (1H, dd), 6.43 (1H, dd), 7.04 (1H, s), 7.15 (1H, t), 7.20-7.27 (2H, m), 7.53 (1H, d), 7.91 (1H, s), 8.24 (1H, d), 8.33 (1H, d), 8.68 (1H, s), 9.14 (1H, s), 10.22 (1H, s); *m/z:* $ES^+$ $MH^+$ 500.42.

**Example 28 (Alternative synthesis 1): *N*-(2-{2-Dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide**

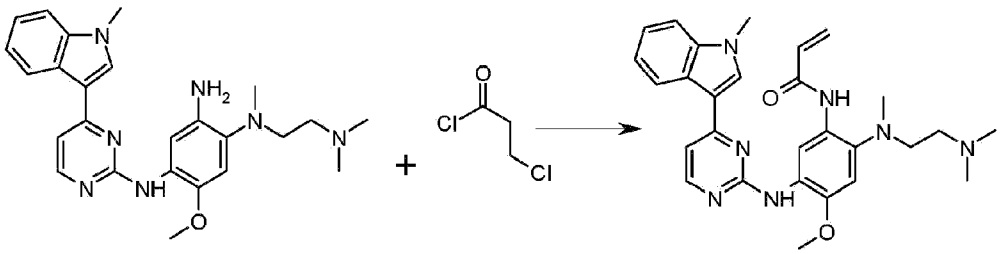
**[0176]**



**[0177]** To a stirred solution of 3-chloro-*N*-[2-[2-dimethylaminoethyl(methyl)amino]-4-methoxy-5-[[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino]phenyl]propanamide **(Intermediate 174,** 31.5 g, 58.76 mmol) in acetonitrile (310 mL) was added triethylamine (17.84 g, 176.28 mmol) at r.t. The resulting mixture was heated to 80°C for 6h then cooled to r.t.. Water (130 mL) was then added and the mixture stirred for 12h. The mixture was then filtered, washed with a mixture of water and acetonitrile (160 mL, 1:1) and dried at 50°C for overnight to give the title compound (19.2 g, 94%) as a solid form identified herein as polymorphic form D. $^1$H NMR: 2.69 (3H, s), 2.83 (6H, d), 3.35 (4H, s), 3.84 (3H, s), 3.91 (3H, s), 5.75 (1H, d), 6.28 (1H, d), 6.67 (1H, dd), 7.05-7.23 (2H, m), 7.29 (1H, t), 7.43 (1H, d), 7.56 (1H, d), 8.21 (2H, s), 8.81 (1H, s), 9.47 (1H, s), 9.52 (1H, s), *m/z:* $ES^+$ $MH^+$ 500.26.

**Example 28 (Alternative synthesis 2): *N*-(2-{2-Dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide**

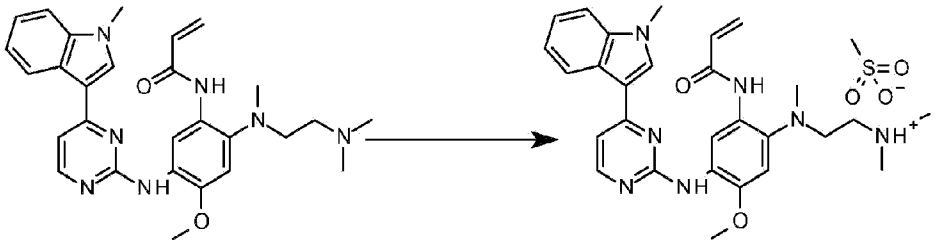
**[0178]**



**[0179]** To a stirred solution of $N^1$-(2-dimethylaminoethyl)-5-methoxy-$N^1$-methyl-$N^4$-[4-(1-methylindol-3-yl)pyrimidin-2-yl]benzene-1,2,4-triamine **(Intermediate 100,** 10 g, 21.32 mmol) in THF (95 mL) and water (9.5 mL) at 0°C was added the 3-chloropropanoyl chloride (3.28 g, 25.59 mmol). The mixture was stirred at r.t. for 15 minutes then NaOH (3.48 g, 85.28 mmol) was added. The resulting mixture was heated to 65°C for 10h. The mixture was then cooled to r.t. and $CH_3OH$ (40 mL) and water (70 mL) were added. The resulting mixture was stirred overnight. The resulting solid was collected by filtration, washed with water (25 mL) and dried at 50°C for 12h to give the title compound (7.0 g, 94%) as a solid form identified herein as polymorphic Form D. $^1$H NMR: 2.69 (3H, s) 2.83 (6H, d) 3.35 (4H, s) 3.84 (3H, s) 3.91 (3H, s) 5.75 (1H, d) 6.28 (1H, d) 6.67 (1H, dd) 7.05-7.23 (2H, m) 7.29 (1H, t) 7.43 (1H, d) 7.56 (1H, d) 8.21 (2H, s) 8.81 (1H, s) 9.47 (1H, s) 9.52 (1H, s) $ES^+$ $MH^+$ 500.26.

**Example 28A: *N*-(2-{2-Dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide mesylate salt**

**[0180]**



**[0181] Procedure 1:** To a stirred solution of *N*-[2-[2-dimethylaminoethyl(methyl)amino]-4-methoxy-5-[[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino]phenyl]prop-2-enamide **(Example 28,** 20 g, 36.63 mmol) in ethanol (120 mL) and EtOAc (80 mL) at 70°C was added methane sulfonic acid (3.59 g, 36.63 mmol) as a solution in EtOAc (40 mL). The resulting mixture was stirred for 1.5h. The resulting solid was collected by filtration and dried at 80°C under vacuum overnight to give the title salt (20.5 g, 94%) in a solid form defined herein as polymorphic Form B for this salt.

**[0182] Procedure 2:** To a stirred solution of *N*-[2-[2-dimethylaminoethyl(methyl)amino]-4-methoxy-5-[[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino]phenyl]prop-2-enamide **(Example 28,** 5

g, 9.11 mmol) in acetone (45.5 mL) and water (4.55 mL) at 50°C was added methane sulfonic acid (0.893 g, 9.11 mmol) as a solution in acetone (4.55 mL). The resulting mixture was stirred for 1.5h. The resulting solid was collected by filtration and dried at 80°C under vacuum overnight to give the title salt (4.9 g, 94%) in a solid form defined herein as polymorphic Form B for this salt; $^1$H NMR (acetone-$d^6$): 2.72 (3H, s), 2.96 (3H, s), 3.01 (6H, s), 3.58 (3H, t), 3.87-3.90 (7H, m), 5.76 (1H, dd), 6.38-6.53 (2H, m), 7.12 (1H, t), 7.20 (1H, t), 7.29 (1H, s), 7.40 (2H, t), 8.07-8.16 (3H, m), 8.56 (1H, s), 9.30 (1H, s), 9.60 (1H, s), 9.66 (1H, s); *m/z:* $ES^+$ $MH^+$ 500.26.

**[0183] Procedure 3:** Polymorphic Form A of *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide mesylate salt was prepared in a similar manner as described above on a ~50 mg scale, except that acetonitrile was used as the solvent. Specifically, ~9.6mg methanesulfonic acid was dissolved into a minimum volumn of acetonitrile. ~50 mg *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)-prop-2-enamide was also dissolved into a minimum volume of acetonitrile and then the resulting solution was added to the methanesulfonic acid solution. Formation of a solid resulted upon addition. This solid was collected by filtration and was air-dried and then analysed. The particular solid form produced in this experiment was designated as Polymorphic Form A for this salt.

**Intermediate 11 (Reference): 3-(2,5-Dichloropyrimidin-4-yl)-1*H*-indole**

**[0184]** $CH_3MgBr$ (3.2M in 2-methyltetrahydrofuran, 3.37 mL, 10.79 mmol) was added dropwise over 10 minutes to a solution of indole (1.28 g, 10.79 mmol) in THF (6 mL) at 0°C. The solution was then stirred at 0-2°C for 0.5h. 2,4,5-Trichloropyrimidine (1 g, 5.40 mmol) was then added dropwise, resulting in a yellow solution. The ice bath was removed, then the solution was stirrred at r.t. for 1h, resulting in a red solution. The mixture was heated to 60°C and then stirred at 60°C for 1.5h. The mixture was then cooled to r.t. and acetic acid (634 µL, 11.06 mmol) was added dropwise. Water (9.90 mL) and THF (2 mL) were added, then the mixture was stirred for 20 minutes at 60°C, resulting in a bi-phasic solution. The layers were separated and heptane (11 mL) was added to the organic solution, resulting in the crystallisation of a solid. The solid was collected by filtration, washed with heptane (2 mL), and dried in a vacuum oven to give the title compound (1.015 g, 66%) as a yellow solid; $^1$H NMR: 7.24-7.32 (2H, m), 7.55-7.58 (1H, m), 8.52-8.55 (1H, m), 8.71-8.73 (2H, m), 12.24 (1H, s); *m/z:* $ES^+$ $MH^+$ 264, 266.

**Intermediate 23 : 4-Fluoro-2-methoxy-5-nitroaniline**

**[0185]** 4-Fluoro-2-methoxyaniline (2.4 g, 17.00 mmol) was added portionwise to concentrated $H_2SO_4$ (15 mL) which was cooled in a ice/water bath, and where the temperature was kept

below 15°C during the addition. The mixture was stirred until all the solid that formed had dissolved. $KNO_3$ (0.815 mL, 17.00 mmol) was added portionwise such that the temperature was maintained below 10°C. The mixture was stirred overnight and then poured onto ice/water. The mixture was basified with concentrated $NH_4OH$. The resulting solid was filtered off and then dissolved in $CH_2Cl_2$, washed with water, dried ($Na_2SO_4$) and concentrated onto silica. Purification by FCC, eluting with 50-0% heptane in $CH_2Cl_2$ gave the title compound (2.450 g, 77%) as a yellow crystalline solid; $^1$H NMR: 3.91 (3H, s), 5.21 (2H, s), 7.03 (1H, d), 7.35 (1H, d); *m/z:* $ES^+$ $MH^+$ 187.4.

**Intermediate 87 (Reference): 5-Chloro-*N*-(4-fluoro-2-methoxy-5-nitrophenyl)-4-(1-methylindol-3-yl)pyrimidin-2-amine**

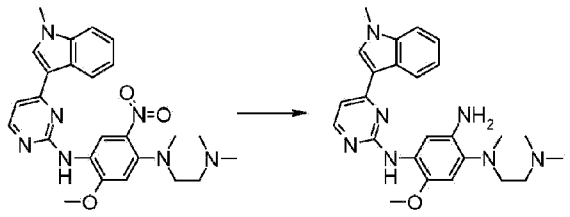
**[0186]** A mixture of 3-(2,5-dichloropyrimidin-4-yl)-1-methylindole **(Intermediate 88,** 1281 mg, 4.60 mmol), *p*-toluene sulphonic acid monohydrate (964 mg, 5.07 mmol) and 4-fluoro-2-methoxy-5-nitroaniline **(Intermediate 23,** 900 mg, 4.84 mmol) in 2-pentanol (50 mL) was heated at 125°C for 18h. A preciptate formed from the solution upon cooling. The precipitate was collected by filtration, washed with $CH_3OH$ (10 mL) and diethyl ether (20 mL) and dried on the filter to give the title compound (1.42 g, 72%) as a tan solid, which was used without further purification; $^1$H NMR: 3.91 (3H, s), 3.96 (3H, s), 7.05 (1H, t), 7.23-7.3 (1H, m), 7.39 (1H, d), 7.53 (1H, d), 8.33 (1H, d), 8.47 (1H, s), 8.58 (1H, s), 8.65 (1H, d), 8.76 (1H, s); *m/z:* $ES^+$ $MH^+$ 428.10.

**Intermediate 88 (Reference) : 3-(2,5-Dichloropyrimidin-4-yl)-1-methylindole**

**[0187]** NaH (0.795 g, 19.88 mmol) was added to 3-(2,5-dichloropyrimidin-4-yl)-1*H*-indole **(Intermediate 11,** 5.0 g, 18.9 mmol) in THF (200 mL) at 0°C under $N_2$ and the mixture was stirred at 0°C for 0.25h. $CH_3I$ (1.243 mL, 19.88 mmol) was then added and the mixture was allowed to warm to r.t. and was stirred for 1h. The mixture was cooled again in an ice bath and further NaH (0.795 g, 19.88 mmol) was added. The suspension was stirred at 0°C for 10 minutes then $CH_3I$ (1.243 mL, 19.88 mmol) was added and the mixture was stirred for 1h. The mixture was then diluted with water (100 mL) which resulted in the formation of some solid. The solid was collected by filtration and was washed with water and EtOAc and then dried, to give the title compound (3.67 g, 70%) as a beige solid. The organic solution was further washed with water and sat. brine and then dried ($MgSO_4$) and concentrated *in vacuo.* Trituration of the residue with diethyl ether gave a solid which was collected by filtration and dried *in vacuo* to give the title compound (477 mg, 9%) as a brown solid: This material was only 71% pure so it was kept separate from the earlier batch; $^1$H NMR: 3.97 (3H, s), 7.34 (2H, dtd), 7.59-7.65 (1H, m), 8.56 (1H, dd), 8.73 (1H, s), 8.79 (1H, s); *m/z:* $ES^+$ $MH^+$ 278.06.

**Intermediate 100: *N*$^1$-(2-Dimethylaminoethyl)-5-methoxy-*N*$^1$-methyl-*N*$^4$-[4-(1-methylindol-3-yl)pyrimidin-2-yl]benzene-1,2,4-triamine**

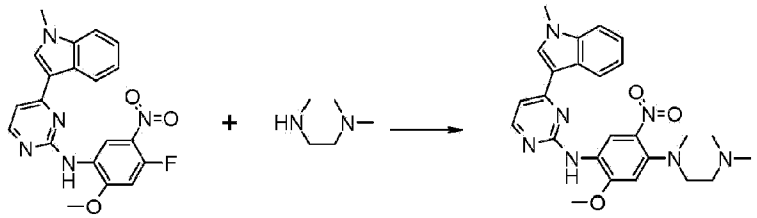
**[0188]**



**[0189]** A mixture of *N'*-(2-dimethylaminoethyl)-2-methoxy-*N'*-methyl-*N*-[4-(1-methylindol-3-yl)pyrimidin-2-yl]-5-nitrobenzene-1,4-diamine **(Intermediate 101,** 220 mg, 0.46 mmol), iron (155 mg, 2.78 mmol) and $NH_4Cl$ (17.32 mg, 0.32 mmol) in ethanol (12 mL) and water (4 mL) was heated at reflux for 2h. The crude mixture was purified by ion exchange chromatography, using an SCX column. The desired product was eluted from the column using 7M methanolic ammonia and appropriate fractions were combined and concentrated *in vacuo* onto silica. Purification by FCC, eluting with 0-5% 7N methanolic ammonia in $CH_2Cl_2$ gave the title compound (175 mg, 85%) as a beige foam; $^1$H NMR: 2.17 (6H, s), 2.36 (2H, t), 2.63 (3H, s), 2.88 (2H, t), 3.74 (3H, s), 3.88 (3H, s), 4.58 (2H, br s), 6.76 (1H, s), 7.12-7.19 (2H, m), 7.21-7.27 (1H, m), 7.48 (1H, s), 7.51 (1H, d), 7.78 (1H, s), 8.27 (1H, d), 8.30 (1H, s), 8.42 (1H, d); *m/z:* $ES^+$ $MH^+$ 446.32.

**Intermediate 101: *N'*-(2-Dimethylaminoethyl)-2-methoxy-*N'*-methyl-*N*-[4-(1-methylindol-3-yl)pyrimidin-2-yl]-5-nitrobenzene-1,4-diamine**

**[0190]**

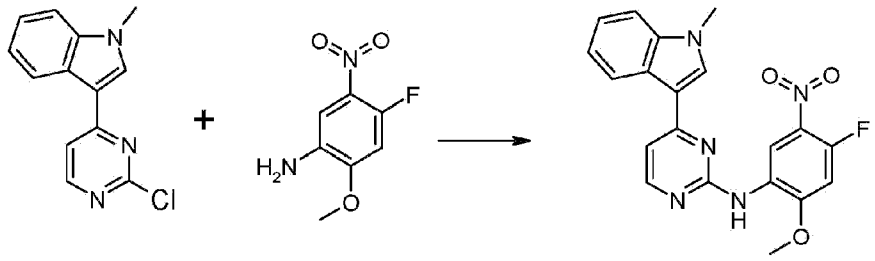


**[0191]** *N*$^1$,*N*$^1$,*N*$^2$-trimethylethane-1,2-diamine (80 mg, 0.79 mmol) was added to a suspension of *N*-(4-fluoro-2-methoxy-5-nitrophenyl)-4-(1-methylindol-3-yl)pyrimidin-2-amine **(Intermdiate 129,** (which may be prepared by the method described for **Intermediate** 87); 350 mg, 0.79 mmol) and DIPEA (0.342 mL, 1.97 mmol) in 2,2,2-trifluoroethanol (5 mL). The mixture was heated in a microwave at 140°C for 1h. The cooled reaction mixture was purified by ion exchange chromatography, using an SCX column. The desired product was eluted from the

column using 7M methanolic ammonia and appropriate fractions were combined and concentrated *in vacuo* onto silica. Purification by FCC, eluting with 0-4% 7N methanolic ammonia in $CH_2Cl_2$ gave the title compound (230 mg, 62%) as an orange solid; $^1$H NMR: 2.16 (6H, s), 2.45-2.49 (2H, t, obscured by DMSO peak), 2.86 (3H, s), 3.26 (2H, t), 3.87 (3H, s), 3.95 (3H, s), 6.85 (1H, s), 7.11 (1H, t), 7.21 (1H, d), 7.25 (1H, t), 7.52 (1H, d), 8.10 (1H, s), 8.31 (1H, d), 8.33 (1H, s), 8.36 (1H, d), 8.62 (1H, s); *m/z:* $ES^+$ $MH^+$ 476.40.

**Intermediate 129: *N*-(4-Fluoro-2-methoxy-5-nitrophenyl)-4-(1-methylindol-3-yl)pyrimidin-2-amine**

**[0192]**



**[0193]** *p*-Toluenesulfonic acid hydrate (22.73 g, 119.5 mmol) was added in one portion to a mixture of 3-(2-chloropyrimidin-4-yl)-1-methylindole **(Intermediate 130,** 24.27 g, 99.58 mmol) and 4-fluoro-2-methoxy-5-nitroaniline **(Intermediate 23,** 18.54 g, 99.58 mmol) in 2-pentanol (500 mL). The resulting mixture was stirred at 105°C for 2.5h. and then cooled to r.t. The resulting precipitate was collected by filtration, washed with 2-pentanol (50 mL) and dried under vacuum to give some of the desired product as a yellow solid. The filtrate was cooled and the resulting precipitate was collected by filtration and washed with 2-pentanol (10 mL). The two crops of product were combined and triturated with $CH_3CN$ to give a solid which was collected by filtration and dried under vacuum to give the title compound (37.4 g, 95%) as a yellow solid; $^1$H NMR: 3.92 (3H, s), 4.01 (3H, s), 7.13 (1H, dd), 7.27-7.36 (1H, m), 7.40-7.51 (2H, m), 7.59 (1H, d), 8.26 (1H, t), 8.35 (1H, d), 8.61 (1H, s), 8.85 (1H, d), 9.46 (1H, s); *m/z:* $ES^-$ $M^-$ 392.

**Intermediate 130: 3-(2-Chloropyrimidin-4-yl)-1-methylindole**

**[0194]** NaH (1.707 g, 42.68 mmol, 40% dispersion in mineral oil) was added in small portions to a cooled (0°C) mixture of 3-(2-chloropyrimidin-4-yl)-1*H*-indole **(Intermediate 131,** 8.168 g, 35.57 mmol) in THF (250 mL). The resulting mixture was stirred at 0°C for 0.5h and then $CH_3I$ (2.67 mL, 42.68 mmol) was added and the mixture stirred at 0°C for a further 3h. The reaction was quenched by the addition of sat. $NaHCO_3$ (25 mL). The mixture was then diluted with EtOAc (100 mL), and the resulting solution was washed with sat. $NaHCO_3$ (50 mL), water (50

mL) and sat. brine (50 mL). The organic solution was then concentrated *in vacuo.* Purification by FCC, eluting with 0-20% $CH_3OH$ in $CH_2Cl_2$ gave the title compound (8.35 g, 96%) as a pale yellow solid; $^1H$ NMR: 3.90 (3H, s), 7.30 (2H, pd), 7.54-7.60 (1H, m), 7.82 (1H, d), 8.38-8.44 (1H, m), 8.49 (1H, s), 8.53 (1H, d); *m/z:* $ES^+$ $MH^+$ 244.

**Intermediate 130: 3-(2-Chloropyrimidin-4-yl)-1-methylindole (Alternative synthesis)**

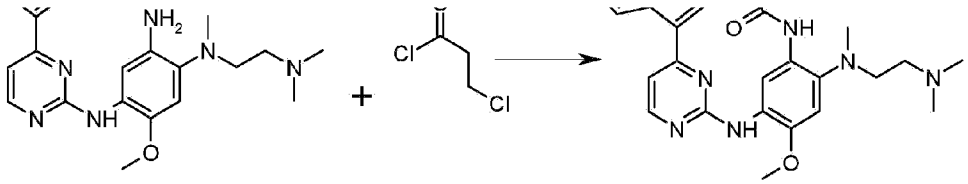
**[0195]** $AlCl_3$ (197 g, 1.477 mol) was added portionwise to a solution of 2,4-dichloro-pyrimidine (200 g, 1342 mmol) in dimethoxyethane (2 L) while maintaining the temperature below 30°C, and the mixture was stirred for 10 minutes. 1-Methylindole (0.172 L, 1.342 mol) was then added and the mixture was heated to 80°C for 2h and then left to cool overnight. The mixture was then poured into stirring water (20 L) and then was stirred for a further 1h. The mixture was then filtered and the resulting solid was washed with water (3 L). The solid was then air-dried for 16h, to give a pink solid (315 g). This solid was then stirred in refluxing $CH_3CN$ (6.3 L) for 1.5h at which point water (630 mL) was added. The mixture was then allowed to cool to r.t. and was stirred for 18h. The mixture was then stirred at 5°C for 0.5h then the resulting solid was collected by filtration. The solid was then washed with cold 10% $CH_3CN$/water (2 × 1L) and then dried to give the title compound (220 g, 67%) as a cream solid.

**Intermediate 131: 3-(2-Chloropyrimidin-4-yl)-1*H*-indole**

**[0196]** $CH_3MgBr$ (3M in diethyl ether, 22.68 mL, 68.03 mmol) was added dropwise over a period of 10 minutes to a stirred solution of 1*H*-indole (7.97 g, 68.03 mmol) in 1,2-dichloroethane (250 mL) at 0°C under an atmosphere of $N_2$. The resulting solution was stirred for 15 minutes and then 2,4-dichloropyrimidine (15.00 g, 100.69 mmol) was added in one portion. The resulting solution was allowed to warm to r.t. and was stirred for a further 16h. The reaction was quenched by the addition of $CH_3OH$ (25 mL) then the mixture was concentrated *in vacuo* and absorbed onto silica. Purification by FCC, eluting with 0-20% $CH_3OH$ in $CH_2Cl_2$ gave the title compound (7.17 g, 46%) as a yellow solid; $^1H$ NMR 7.20-7.28 (2H, m), 7.49-7.53 (1H, m), 7.91 (1H, d), 8.42 (1H, dd), 8.50 (1H, d), 8.53 (1H, d), 12.06 (1H, s); *m/z:* $ES^+$ $MH^+$ 230.

**Intermediate 174: 3-Chloro-*N*-[2-[2-dimethylaminoethyl(methyl)aminol-4-methoxy-5-[[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino]phenyl]propanamide**

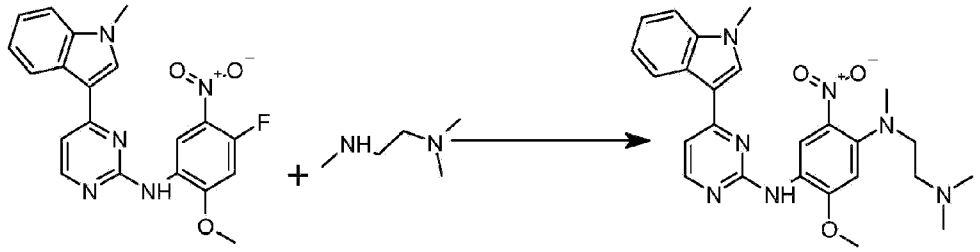
**[0197]**



**[0198]** To a stirred suspension of $N^1$-(2-dimethylaminoethyl)-5-methoxy-$N^1$-methyl-$N^4$-[4-(1-methylindol-3-yl)pyrimidin-2-yl]benzene-1,2,4-triamine **(Intermediate** 175, 33 g, 62.29 mmol) and $K_2CO_3$ (6.09 g, 43.6 mmol) in acetone (300 mL) was added 3-chloropropanoyl chloride (9.78 g, 74.74 mmol) at -50°C. The resulting mixture was heated to -20°C and stirred for 0.5h. $CH_3OH$ (27.75 mL) and NaOH solution (2.24 g, 56.06 mmol in 300 mL water) were added. The resulting mixture was stirred for 3-4h at r.t. Solid was collected by filtration and dried at 50°C to give the title compound (32.5 g, 95%). $^1$H NMR: ($CDCl_3$) 2.95 (2H, t), 3.04 (6H, d), 3.50 (3H, s), 3.63 (2H, s), 3.81 (2H, t), 4.01 (6H, s), 4.33-4.37 (2H, m), 7.33-7.42 (3H, m), 7.47 (1H, t), 7.51-7.55 (1H, m), 8.11-8.21 (3H, m), 8.48 (1H, s), 8.87 (1H, s), 9.17 (1H, s); *m/z:* $ES^+$ $MH^+$ 536.24.

**Intermediate 175: $N^4$-(2-Dimethylaminoethyl)-2-methoxy-$N^4$-methyl-$N^1$-[4-(1-methylindol-3-yl)pyrimidin-2-yl]-5-nitro-benzene-1,4-diamine**

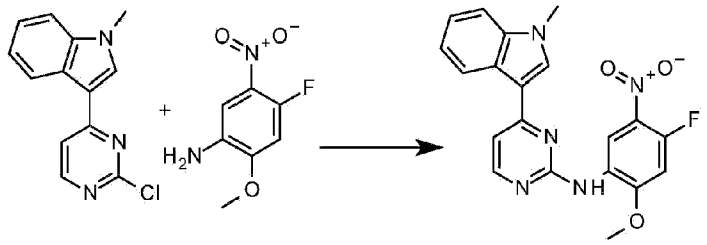
**[0199]**



**[0200]** To a stirred solution of *N*-(4-fluoro-2-methoxy-5-nitro-phenyl)-4-(1-methylindol-3-yl)pyrimidin-2-amine **(Intermediate 176,** 65 g, 160.28 mmol) and *N,N',N'*-trimethylethane-1,2-diamine (19.65 g, 192.3 mmol) in DMA (630 mL) was added *N*-ethyl-*N*-isopropyl-propan-2-amine (26.93 g, 208.4 mmol) at r.t. The resulting mixture was stirred at 85°C for 5-6h then cooled to r.t. Water (630 mL) was then added and the mixture was stirred for 3-4h. Solid material was collected by filtration, washed with water (315 mL) and dried at 50°C for 12h to give the title compound (79.4 g, 96%) as orange solid; $^1$H NMR ($CDCl_3$): 2.29 (6H, s) 2.60 (2H, t), 2.93 (3H, s), 3.31 (2H, t), 3.96 (3H, s), 4.00 (3H, s), 6.69 (1H, s), 7.21 (1H, d), 7.30-7.38 (2H, m), 7.43 (1H, d), 7.56 (1H, s), 8.18 (1H, d), 8.30 (1H, s), 8.41 (1H, d), 9.59 (1H, s); *m/z:* $ES^+$ $MH^+$ 476.23.

**Intermediate 176: *N*-(4-Fluoro-2-methoxy-5-nitro-phenyl)-4-(1-methylindol-3-yl)-pyrimidin-2-amine**

**[0201]**



**[0202]** 1,4-Dioxane (585 mL) was added to a mixture of 3-(2-chloropyrimidin-4-yl)-1-methylindole **(Intermediate 177,** 50 g, 160.04 mmol), 4-fluoro-2-methoxy-5-nitro-aniline (38.03 g, 192.04 mmol) and *p*-toluenesulfonic acid monohydrate (37.09 g, 192.04 mmol) at r.t. The resulting mixture was stirred at 85°C for 3h. After cooling to r.t., the mixture was quenched with 23% aqueous ammonia (39.59 mL, 480.1 mmol) and water (195 mL, 510.1 mmol) and a solid precipitated. The resulting slurry was stirred at r.t. for 3-4h. The solid was collected by filtration and dried at 50°C *in vacuo* for 12h to give the title compound (74.6 g, 85%) as yellow solid; $^1$H NMR ($CDCl_3$): 4.01 (6H, s), 6.90 (1H, d), 7.37-7.48 (4H, m), 8.05-8.12 (2H, m), 8.43 (1H, s), 8.90 (1H, s), 9.34 (1H, s); *m/z:* $ES^+$ $MH^+$ 394.12.

**Intermediate 177: 3-(2-Chloropyrimidin-4-yl)-1-methyl-indole**

**[0203]** To a stirred solution 2, 4-dichloropyrimidine (70.5 g, 463.76 mmol) in dimethoxyethane (900 mL) was added $FeCl_3$ (77.16 g, 459.12 mmol) and 1-methyl indole (68.28 g) at 60°C. The resulting mixture was stirred overnight at 60°C. After cooling, a solid was precipitated by adding methanol (345 mL) and water (900 mL). The resulting slurry was stirred for 3h. The solid was collected by filtration, washed with $CH_3OH$ (1.38 L) and dried at 50°C overnight to give the title compound (138.7 g, 81.5%) as a purple solid; $^1$H NMR ($CDCl_3$) 3.89 (3H, s), 7.36-7.41 (3H, m), 7.49 (1H, s), 7.96 (1H, s), 8.34 (1H, s), 8.45 (1H, s); *m/z:* $ES^+$ $MH^+$ 244.05.

**Useful crystalline polymorphic forms of *N*-{2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide (referred to herein as "Compound X") and its mesylate salt (referred to herein as "Mesylate Salt Y")**

**Polymorphic Form A of Compound X (Reference)**

**[0204]** The initially produced **Compound X** was found to be an amorphous solid. Crystalline polymorphic Form A of **Compound X** was then prepared by taking some of this amorphous **Compound X** (~20 mg) and slurring it in cyclohexane (~2 mL) at 50°C while stirring with a magnetic stirrer bar for ~4 days. Then the sample was allowed to cool, the cap removed from the vial, and the sample was left to dry under ambient conditions to provide Form A of **Compound X.** The X-ray powder diffraction pattern for Form A of **Compound X** is shown in Figure 1. The DSC thermogram of Form A of **Compound X** is shown in Figure 2 which shows an initial event with an onset at 35.1°C and a peak at 50.1°C followed by a subsequent melting endotherm with an with an onset of 80.2°C and a peak at 88.3°C.

**Polymorphic Form B of Compound X (Reference)**

**[0205]** The initially produced **Compound X** was found to be an amorphous solid. Crystalline polymorphic Form B of **Compound X** was then prepared by taking some of this amorphous **Compound X** (~20 mg) and dissolving it in the minimum required amount of EtOAc to achieve full dissolution. This solution was then allowed to evaporate to dryness under ambient conditions to provide Form B of **Compound X.** The X-ray powder diffraction pattern for Form B of **Compound X** is shown in Figure 3. The DSC thermogram of Form B of **Compound X** is shown in Figure 4 which shows a melting endotherm with an onset of 94.1°C and a peak at 113.6°C.

**Polymorphic Form C of Compound X (Reference)**

**[0206]** The initially produced **Compound X** was found to be an amorphous solid. Crystalline polymorphic form C of **Compound X** was then prepared by taking some of this amorphous **Compound X** (~20 mg) and dissolving it in the minimum amount of diethyl ether required to achieve full dissolution. This solution was then allowed to evaporate to dryness under ambient conditions to provide Form C of **Compound X.** The X-ray powder diffraction pattern for Form C of **Compound X** is shown in Figure 5. The DSC thermogram of Form C of **Compound** X is shown in Figure 6 which shows a melting endotherm with an onset of 91.1 °C and a peak at 103.8°C.

**Polymorphic Form D of Compound X (Reference)**

**[0207]** Polymorphic Form D of **Compound X,** which is believed to be a crystalline monohydrate form of **Compound X,** was produced *via* the method described above for Example 28 - Alternative syntheses 1 & 2. The X-ray powder diffraction pattern for Form D of **Compound X** is shown in Figure 7. The DSC thermogram of Form C of **Compound X** is shown in Figure 8 which shows a melting endotherm with an onset of 108.8°C and a peak at 117.7°C. Thermogravimetric analysis indicated a weight loss of approximately 3.3%. which

suggests a monohydrated form (theoretical monohydrate = 3.5%). The TGA thermogram is shown in Figure 9.

**Polymorphic Form E of Compound X (Reference)**

**[0208]** Polymorphic Form E of **Compound X,** which is believed to be a 1.25 stoichiometry hydrated form of **Compound X,** was produced by slurrying **Compound X** [154 g, prepared as described for Example 28 (using acryloyl chloride)] in a mixture of methanol (150 mL) and water (600 mL). 10g of **Compound X** (Form D) was added and the slurry was stirred at r.t. for 4 days. The resulting solid was then collected by filtration and washed with water and allowed to dry. The X-ray powder diffraction pattern for Form E of **Compound X** is shown in Figure 10. The DSC thermogram of Form E of **Compound X** is shown in Figure 11 which shows an initial event with an onset at 66.1°C and a peak at 77.2°C followed by a further event with an onset at 93.6°C and a peak at 101.5°C followed by a subsequent melting endotherm with an with an onset of 130.9°C and a peak at 135.3°C. Thermogravimetric analysis indicated a weight loss of approximately 4.7% which suggests a hydrated form equivalent to a 1.25 stoichiometric hydrate. (theoretical 1.25 hydrate = 4.3%). The TGA thermogram is shown in Figure 12.

**Polymorphic Form F of Compound X (Reference)**

**[0209]** Polymorphic Form F of **Compound X,** which is believed to be a 0.25 stoichiometry hydrated form of **Compound X,** was produced by taking some of the Form E of **Compound X** and drying it in a vacuum oven, at r.t., to constant weight. The X-ray powder diffraction pattern for Form F of **Compound X** is shown in Figure 13. The DSC thermogram of Form F of **Compound X** is shown in Figure 14 which shows an initial event with an onset at 80.9°C and a peak at 92.8°C followed by a subsequent melting endotherm with an with an onset of 130.7°C and a peak at 135.7°C. Thermogravimetric analysis indicated a weight loss of approximately 0.7% which suggests a partially hydrated form equivalent to a 0.25 stoichiometric hydrate. (theoretical 0.25 hydrate = 0.89%). The TGA thermogram is shown in Figure 15.

**Polymorphic Form K of Compound X (Reference)**

**[0210]** This polymorphic form of **Compound X** was produced according to the following method: A solution of acryloyl chloride (0.026 L, 318.48 mmol) in $CH_2Cl_2$ (290 mL) was added dropwise over 25 minutes to a stirred suspension of *N*$^1$-(2-(dimethylamino)ethyl)-5-methoxy-*N*$^1$-methyl-*N*$^4$-(4-(1-methyl-1*H*-indol-3-yl)pyrimidin-2-yl)benzene-1,2,4-triamine (129 g, 289.52 mmol) in $CH_2Cl_2$ (2.9 L) that was cooled to -5°C. The addition is exothermic but the mixture was not permitted to warm to more than 1°C during the addition. The resulting mixture was stirred at -5 °C for 2h. Cold sat. $NaHCO_3$ solution (1L) was then added dropwise, while keeping

the temperature below -2°C. The mixture was then allowed to warm to r.t. The phases were separated, and the resulting organic solution was washed with water (100 mL) and saturated brine (100 mL). The solution was then dried ($MgSO_4$) and concentrated *in vacuo.* The residue was dissolved into 5% $CH_3OH$ in $CH_2Cl_2$ (60 mL) and then filtered. The filtered solution was purified by FCC, eluting with 5% $CH_3OH$ in $CH_2Cl_2$ and clean fractions were combined and concentrated to give impure **Compound X** as a brown gum (96 g). Further purification by chiral preparative HPLC provided a sample of **Compound X** which was slurried in $CH_3OH$ (50 mL). Not all of the **Compound X** material would dissolve. Water was then added (250 mL) and the resulting mixture was slurried overnight with magnetic stirring. The resulting solid was then collected by filtration and dried in a vacuum oven over a weekend to provide 16.2 g of **Compound X** in the polymorphic form defined herein as Form K. $^1H$ NMR: 2.20 (6H, s), 2.28 (2H, m), 2.71 (3H, s), 2.88 (2H, m), 3.85 (3H, s), 3.90 (3H, s), 5.76 (1H, d), 6.27 (1H, d), 6.43 (1H, m), 7.03 (1H, s), 7.15 (1H, m), 7.22 (2H, m), 7.51 (1H, d), 7.87 (1H, s), 8.23 (1H, m), 8.33 (1H, m), 8.68 (1H, s), 9.18 (1H, s), 10.16 (1H, s).

**[0211]** The X-ray powder diffraction pattern for Form K of **Compound** X is shown in Figure 16. The DSC thermogram of Form K of **Compound** X is shown in Figure 17 which shows a melting endotherm with an onset of 129.3°C and a peak at 133.4°C.

**Polymorphic Form A of Mesylate Salt Y (Reference)**

**[0212]** Polymorphic Form A of **Mesylate Salt Y** was prepared by the method described previously (Example 28A, Procedure 3). The X-ray powder diffraction pattern for Form A of **Mesylate Salt Y** is shown in Figure 18. The DSC thermogram of Form A of Mesylate salt Y is shown in Figure 19 which shows an initial event with an onset at 28.1°C and a peak at 62.2°C followed by a subsequent melting endotherm with an with an onset of 258.8°C and a peak at 262.0°C.

**Polymorphic Form B of Mesylate Salt Y**

**[0213]** Polymorphic Form B of **Mesylate Salt Y** was prepared by the method described previously (Example 28A, Procedures 1 and 2). The X-ray powder diffraction pattern for Form B of **Mesylate Salt Y** is shown in Figure 20. The DSC thermogram of Form B of **Mesylate salt Y** is shown in Figure 21 which shows a melting endotherm with an onset of 245.0°C and a peak at 246.5°C.

# REFERENCES CITED IN THE DESCRIPTION

Cited references

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**Patent documents cited in the description**


- WO0194341A [0034]
- WO0047212A [0034]
- WO9722596A [0034]
- WO9730035A [0034]
- WO9732856A [0034]
- WO9813354A [0034]
- WO9902166A [0034]
- WO0040529A [0034]
- WO0041669A [0034]
- WO0192224A [0034]
- WO0204434A [0034]
- WO0208213A [0034]


**Non-patent literature cited in the description**


- New England Journal of Medicine, 2008, vol. 358, 1160-74 [0004]
- Biochemical and Biophysical Research Communications, 2004, vol. 319, 1-11 [0004]
- Science, 2004, vol. 304, 1497-500 [0005]
- New England Journal of Medicine, 2004, vol. 350, 2129-39 [0005]
- Design of ProdrugsElsevier19850000 [0013]
- Methods in EnzymologyAcademic Press19850000vol. 42, 309-396 [0013]
- Design and Application of Prodrugs**H. BUNDGAARD**A Textbook of Drug Design and Development19910000113-191 [0013]
- **H. BUNDGAARD**Advanced Drug Delivery Reviews, 1992, vol. 8, 1-38 [0013]
- **H. BUNDGAARD et al.**Journal of Pharmaceutical Sciences, 1988, vol. 77, 285- [0013]
- **N. KAKEYA et al.**Chem Pharm Bull, 1984, vol. 32, 692- [0013]
- J. Med. Chem., 2004, vol. 47, 6658-6661 [0034]
- **STERN et al.**Critical reviews in oncology/haematology, 2005, vol. 54, 11-29 [0034]

- **JENKINS, RSNYDER, R.L.**Introduction to X-Ray Powder DiffractometryJohn Wiley & Sons19960000 [0054]
- **BUNN, C.W.**Chemical CrystallographyClarendon Press19480000 [0054]
- **KLUG, H. P.ALEXANDER, L. E.**X-Ray Diffraction Procedures, 1974, [0054]

Patentkrav

1. Polymorf form af et mesylatsalt af N-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamid, som har et røntgenpulverdiffraktionsmønster med mindst én specifik peak ved 2-theta = 7,2° eller 8,6°, plus eller minus 0,2° 2-theta, målt ved anvendelse af CuKa-stråling.

2. Polymorf form af mesylatsaltet af N-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamid ifølge krav 1, som har et røntgenpulverdiffraktionsmønster med mindst én specifik peak ved 2-theta = 7,2°, plus eller minus 0,2° 2-theta, målt ved anvendelse af CuKa-stråling.

3. Polymorf form af et mesylatsalt af N-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamid ifølge krav 1, som har et røntgenpulverdiffraktionsmønster med mindst én specifik peak ved 2-theta = 8,6°, plus eller minus 0,2° 2-theta, målt ved anvendelse af CuKa-stråling.

4. Polymorf form af mesylatsaltet af N-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamid ifølge krav 1, som har et røntgenpulverdiffraktionsmønster med mindst to specifikke peaks ved 2-theta = 7,2° og 8.6°, idet disse værdier kan være plus eller minus 0,2° 2-theta, målt ved anvendelse af CuKa-stråling.

5. Polymorf form af mesylatsaltet af N-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamid ifølge et hvilket som helst af kravene 1 til 4, som har et røntgenpulverdiffraktionsmønster med specifikke peaks ved 2-theta = 7,2, 8,6, 15,3, 10,4, 25,7, 26,1, 16,4, 9,5, 22,1 og 18,8°, idet disse værdier kan være plus eller minus 0,2° 2-

theta, målt ved anvendelse af CuKa-stråling.

6. Polymorf form af et mesylatsalt af N-(2-{2-dimethylaminoethylmethylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamid ifølge krav 1, som har et røntgenpulverdiffraktionsmønster, der i det væsentlige er det samme som det røntgendiffraktionsmønster, som er vist i figur 20, når det måles ved anvendelse af CuKa-stråling.

# DRAWINGS

**Figure 1: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form A**

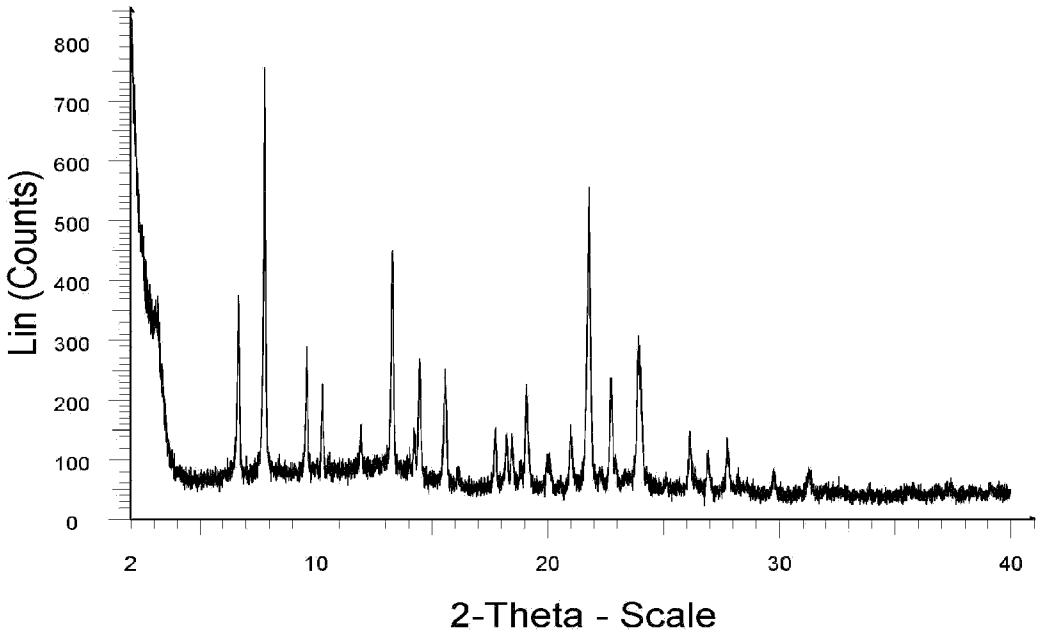

**Figure 2: DSC Thermogram *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form A**

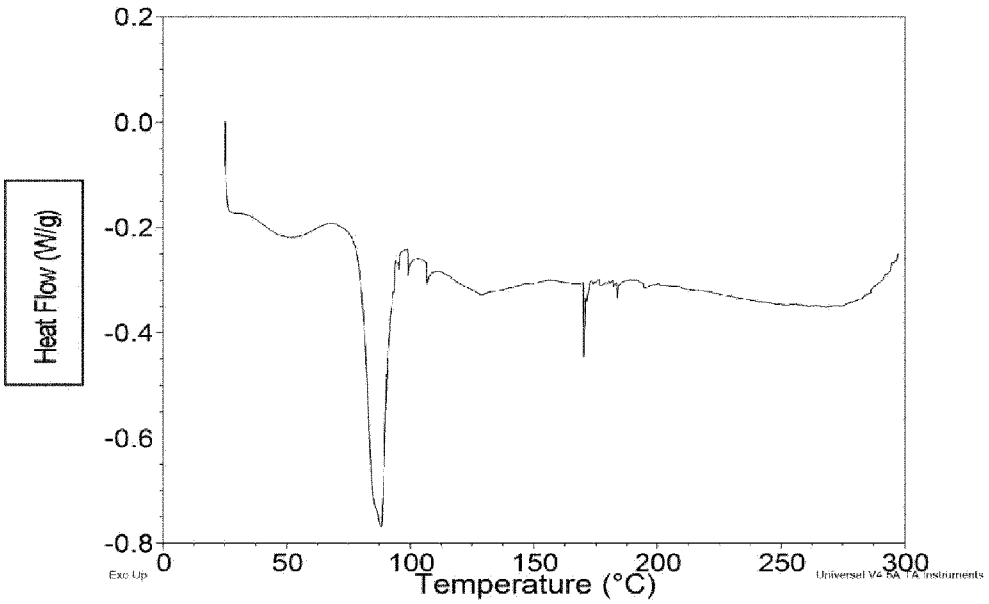

**Figure 3: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form B**

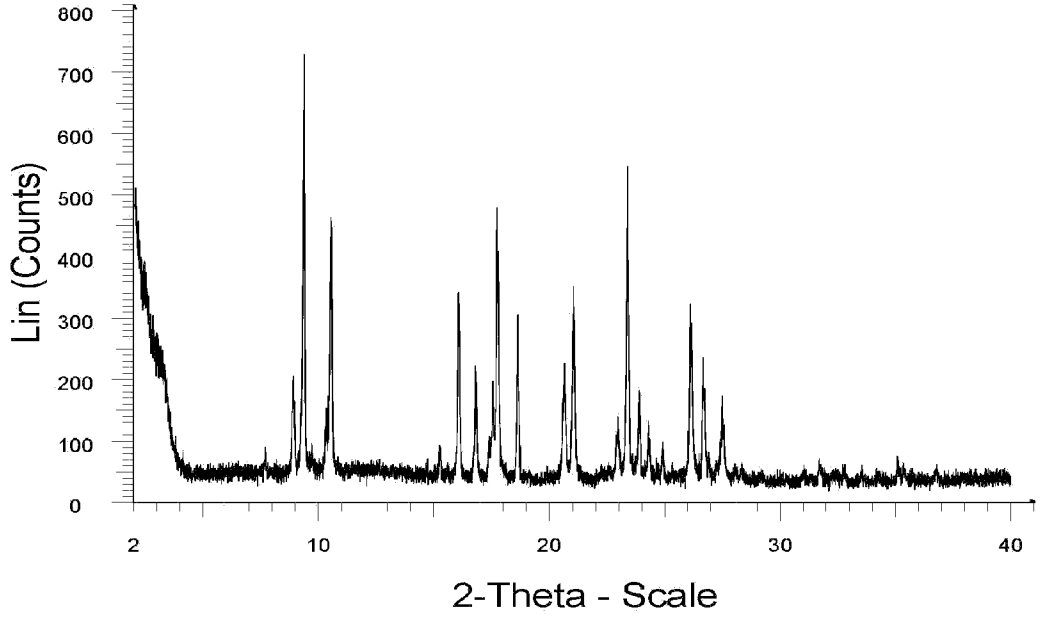

**Figure 4: DSC Thermogram N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form B**

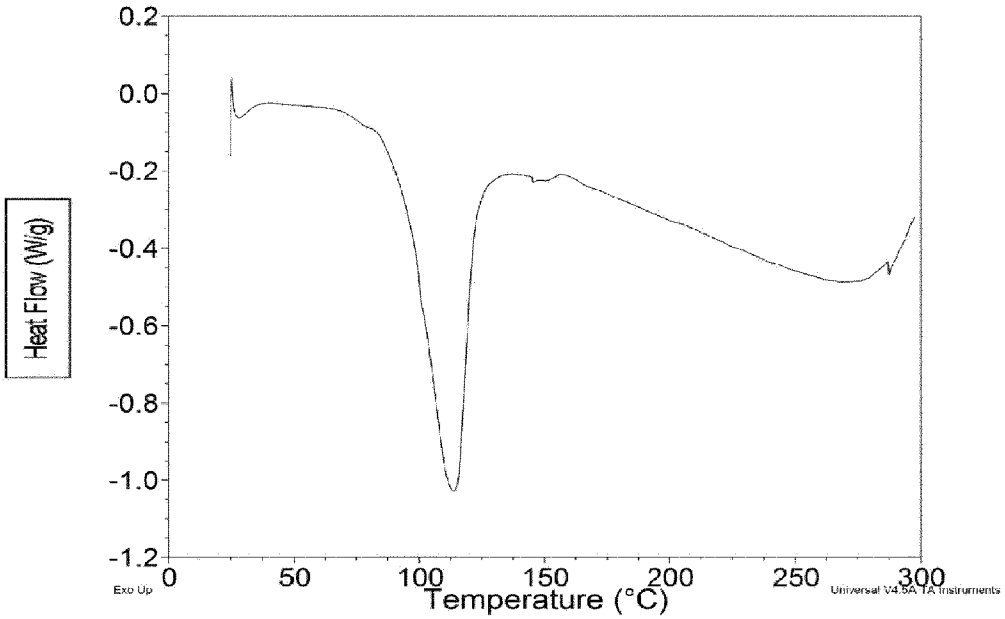

**Figure 5: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form C**

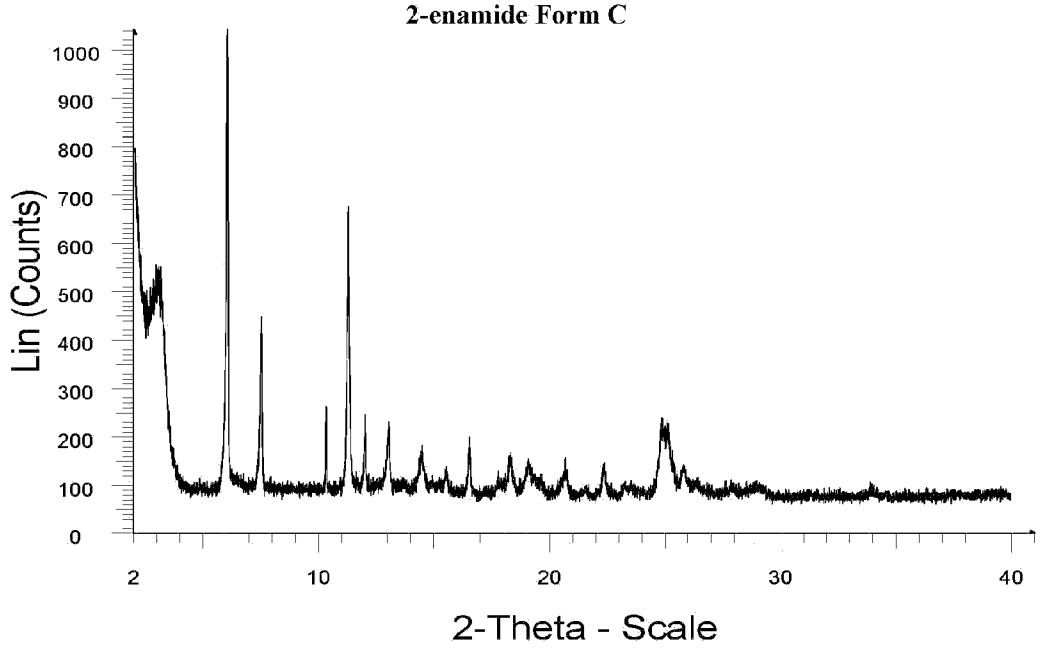

**Figure 6: DSC Thermogram N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form C**

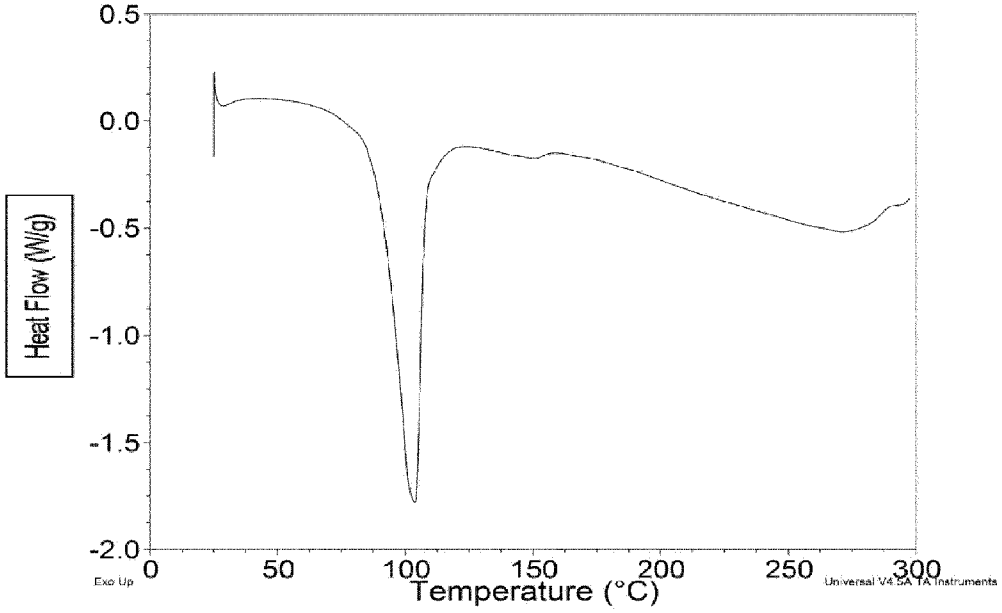

**Figure 7: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form D (Monohydrate)**

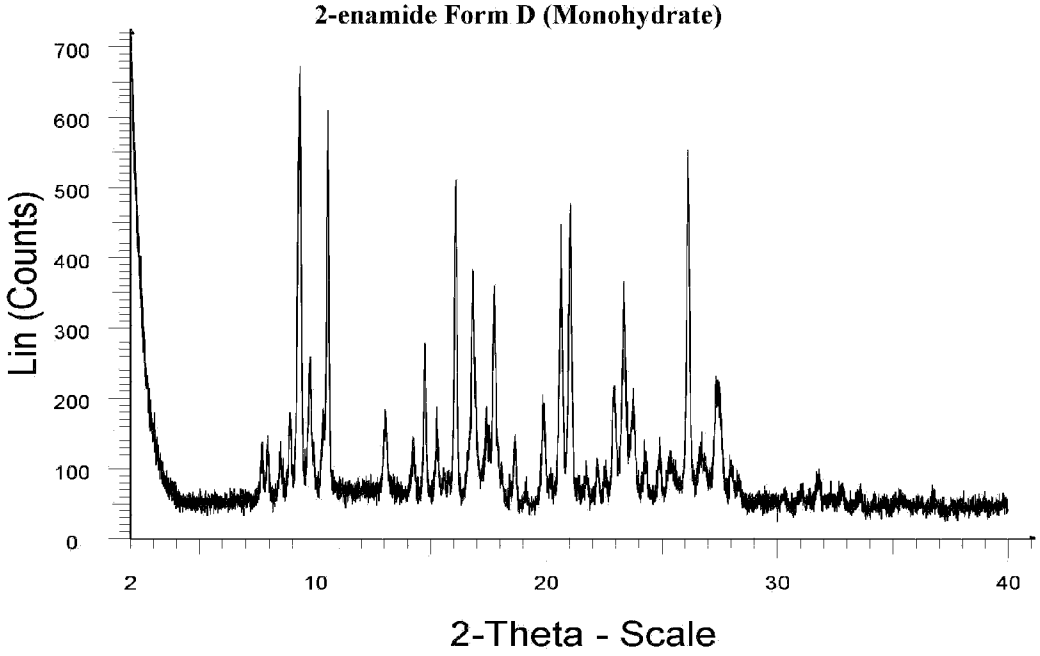

**Figure 8: DSC Thermogram N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form D (Monohydrate)**

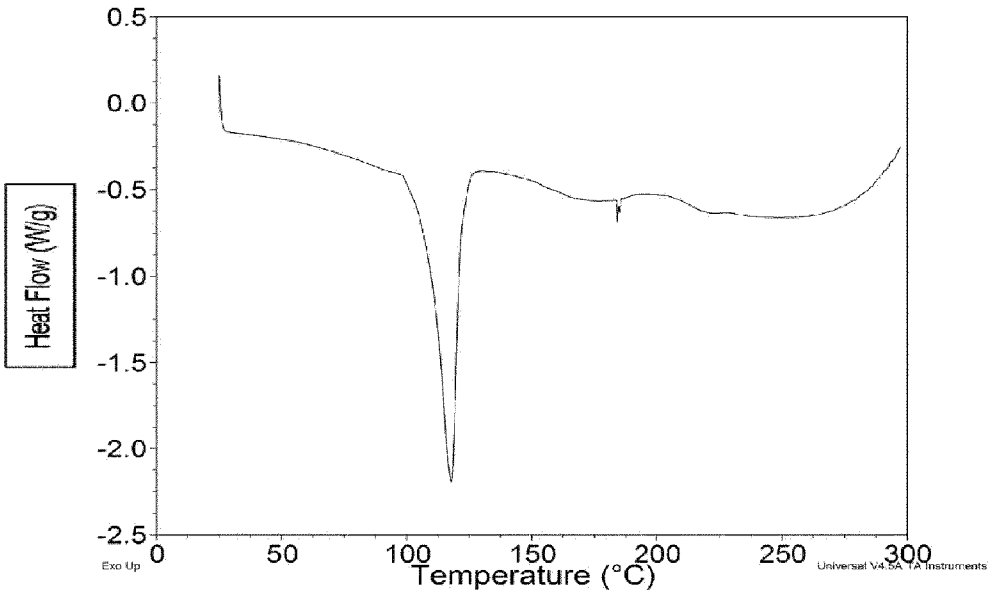

**Figure 9: TGA Thermogram *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form D (Monohydrate)**

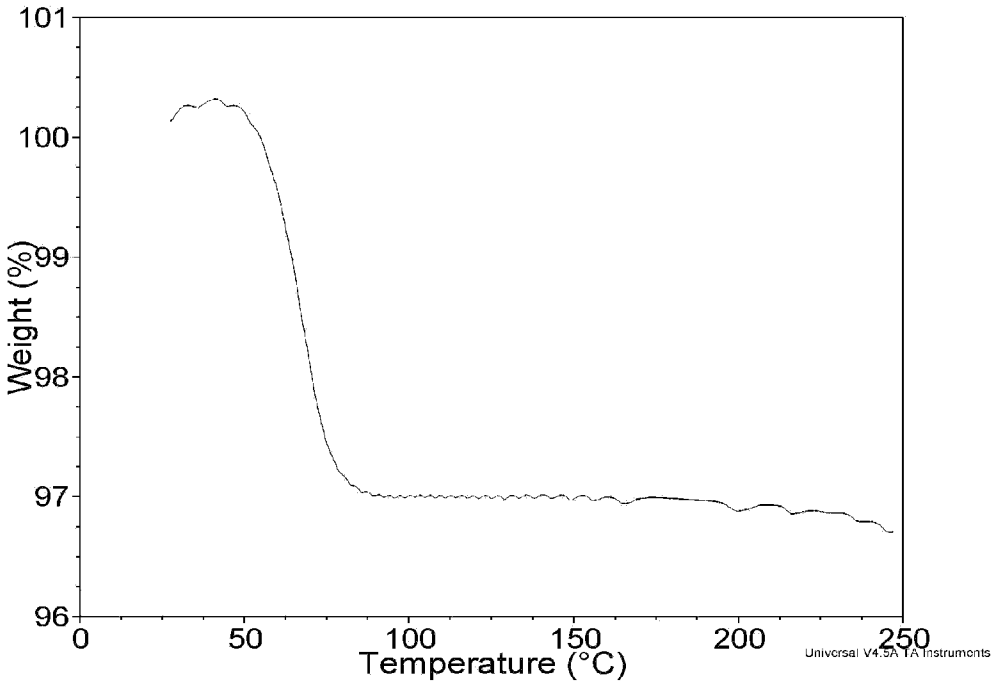

**Figure 10: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form E (Hydrated Form)**

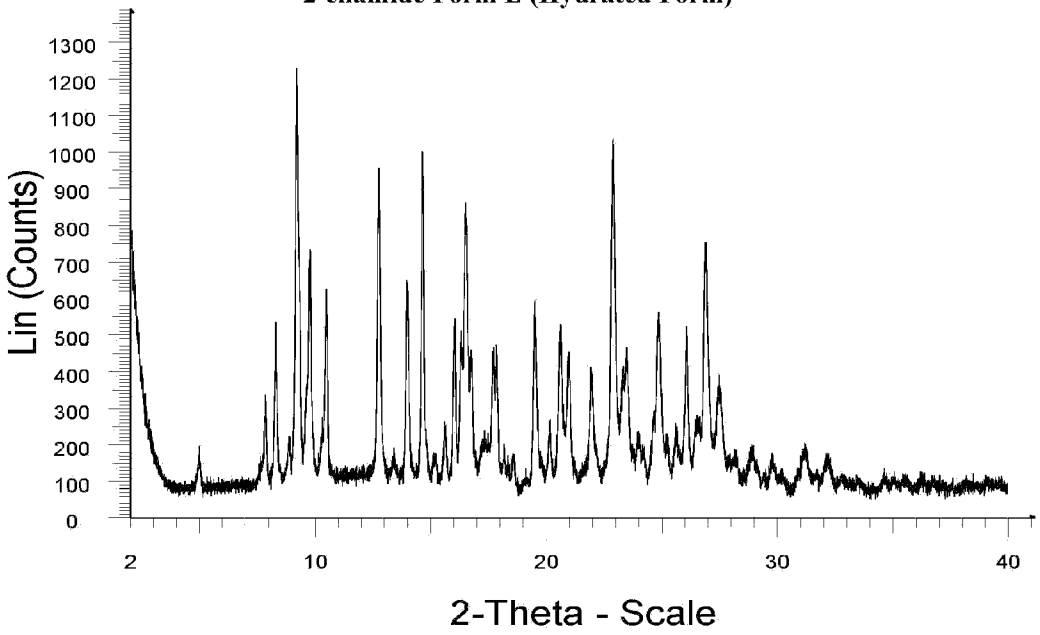

**Figure 11: DSC Thermogram N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form E (Hydrated Form)**

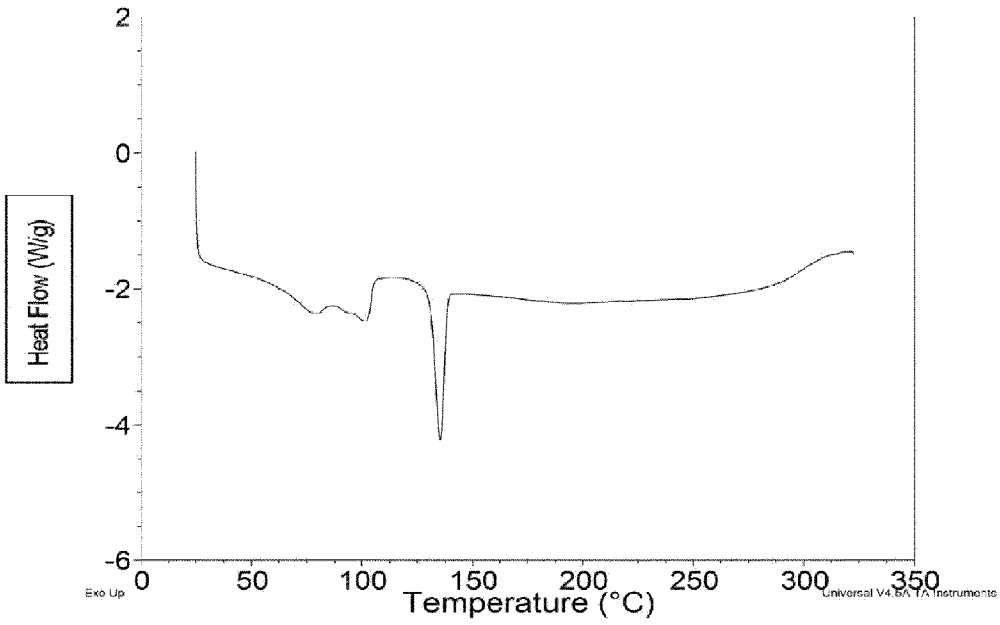

**Figure 12: TGA Thermogram *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form E (hydrated form)**

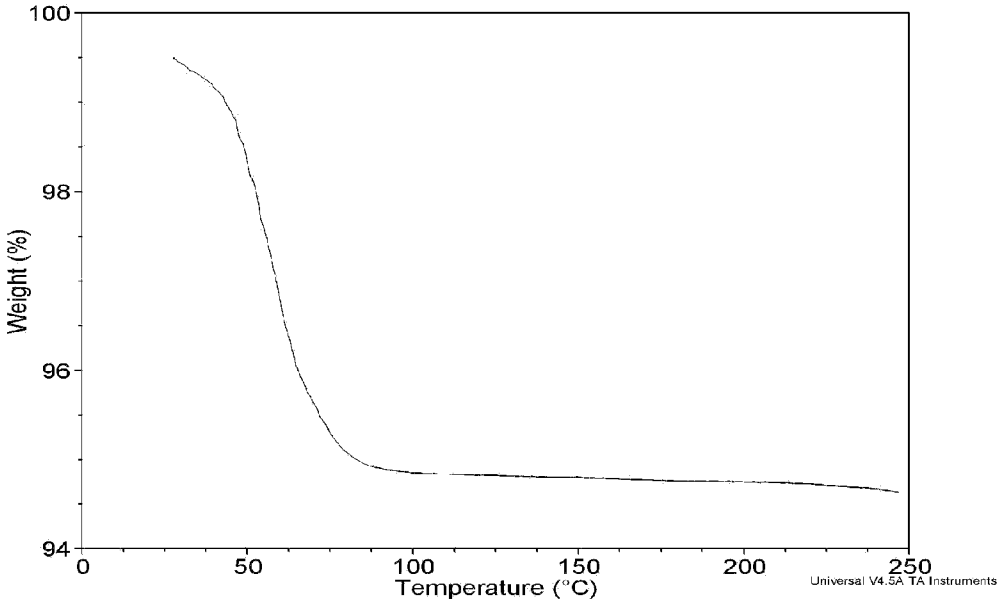

**Figure 13: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form F (Hydrated Form)**

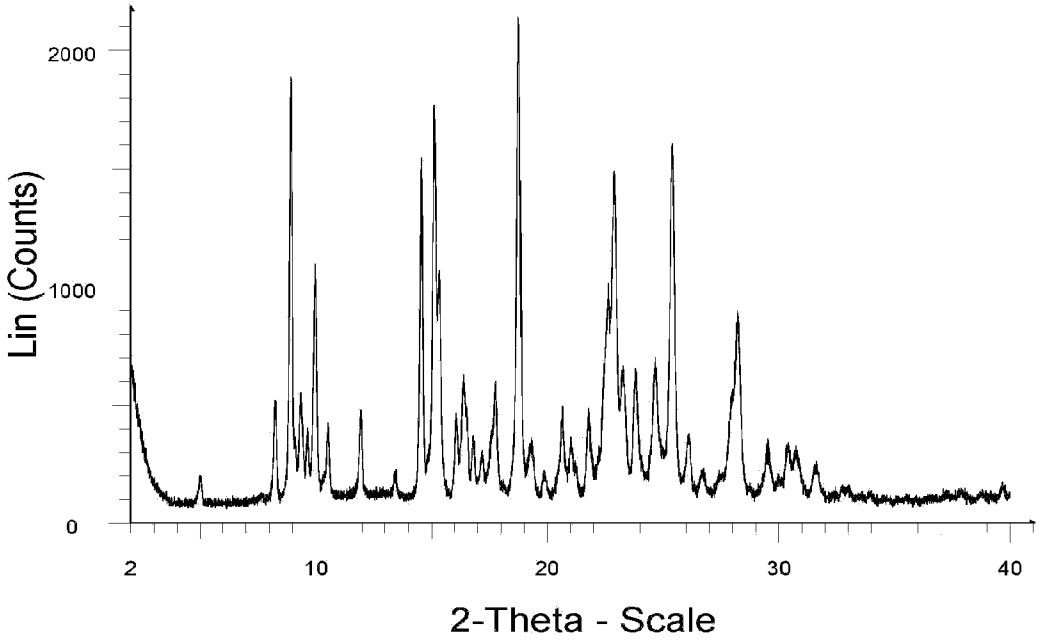

**Figure 14: DSC Thermogram N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form F (Hydrated Form)**

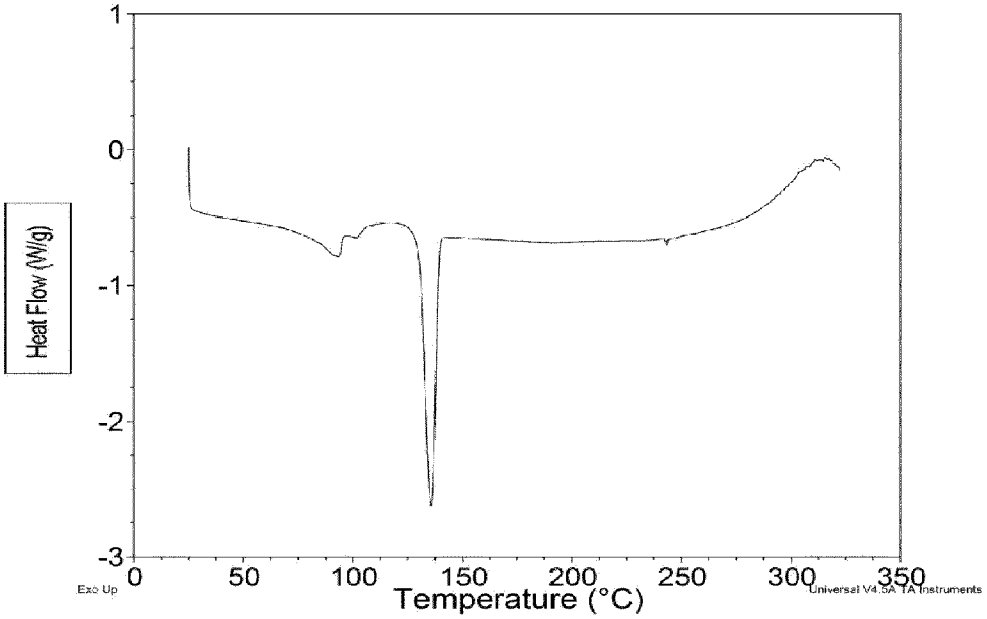

**Figure 15: TGA Thermogram *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form F (hydrated form)**

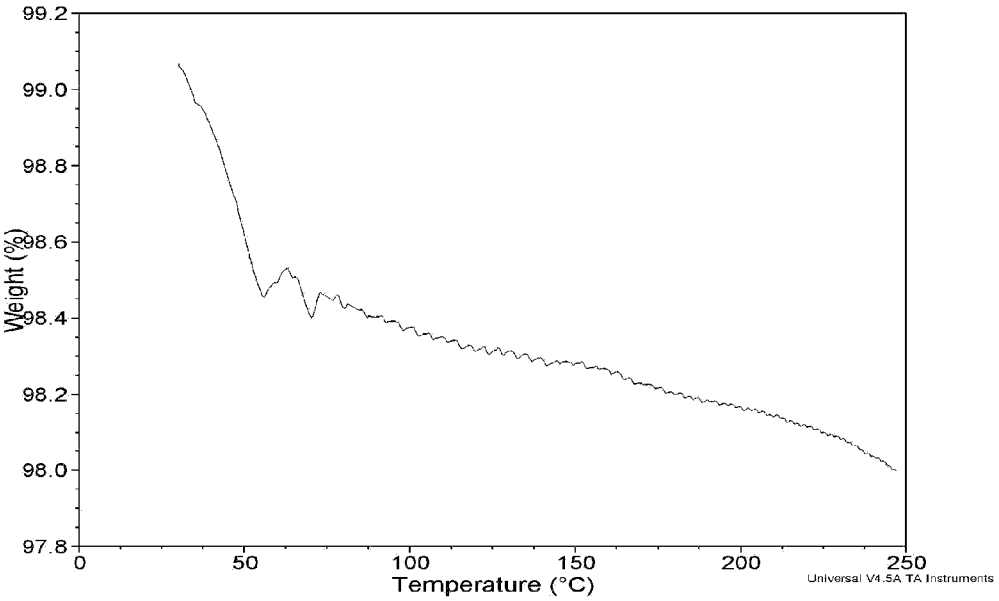

**Figure 16: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form K**

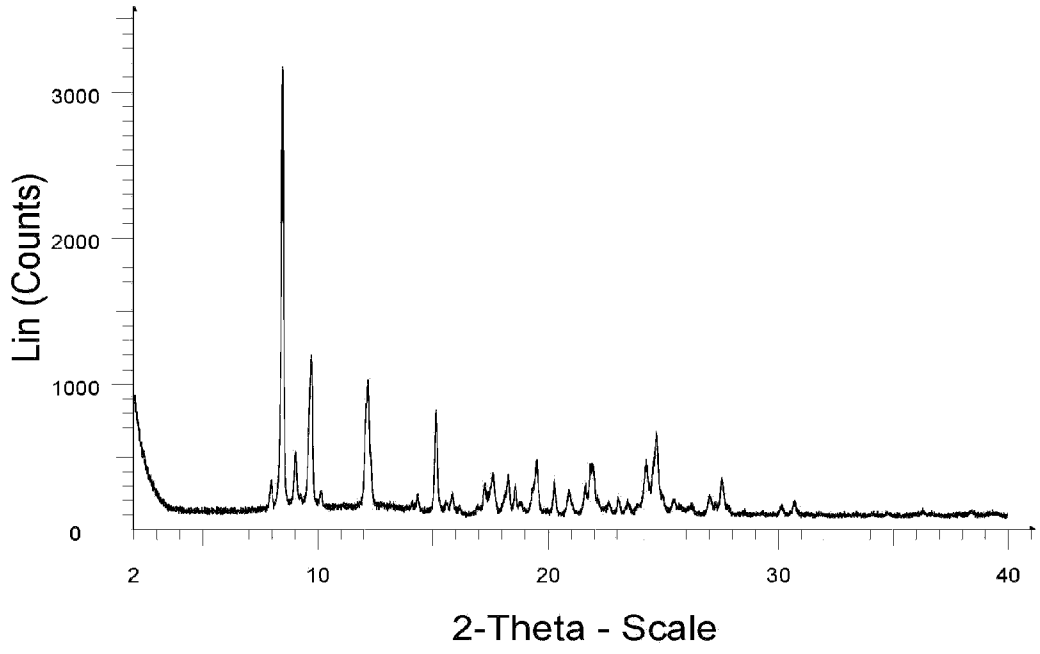

**Figure 17: DSC Thermogram *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Form K**

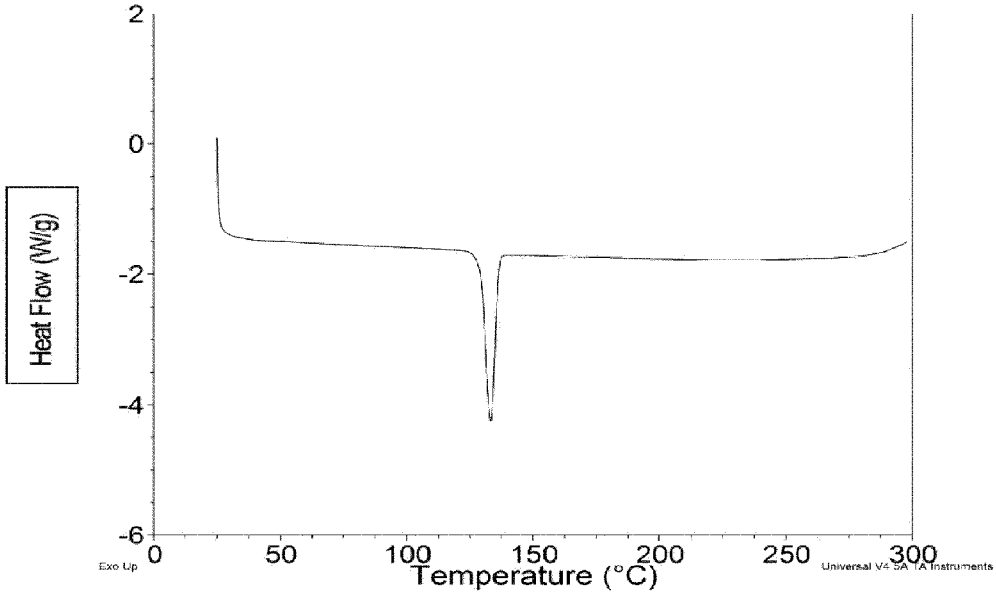

**Figure 18: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Mesylate salt - Form A**

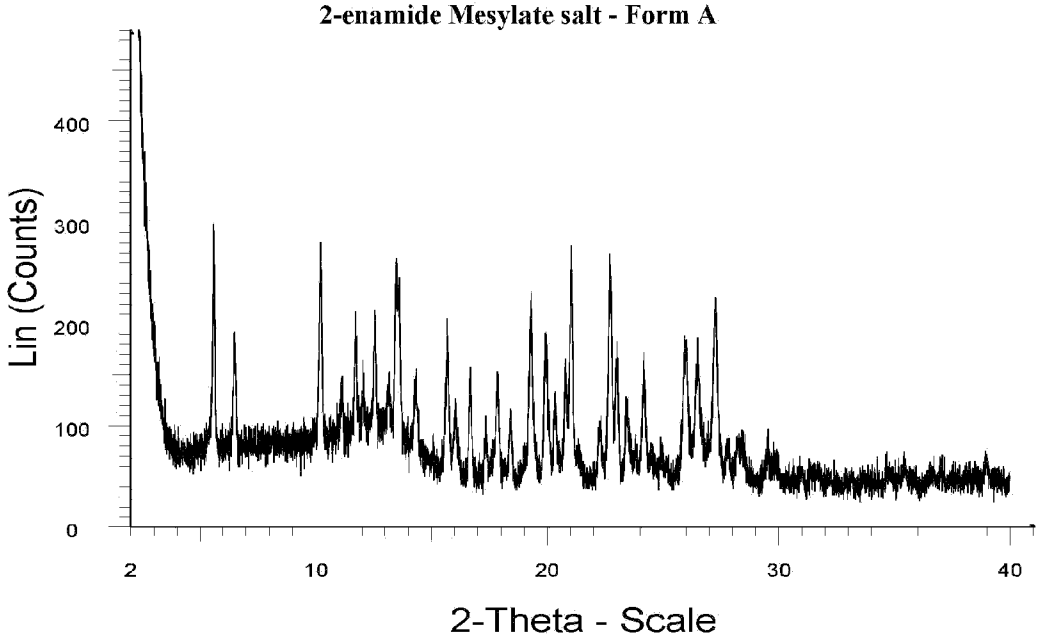

**Figure 19: DSC Thermogram N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Mesylate salt - Form A**

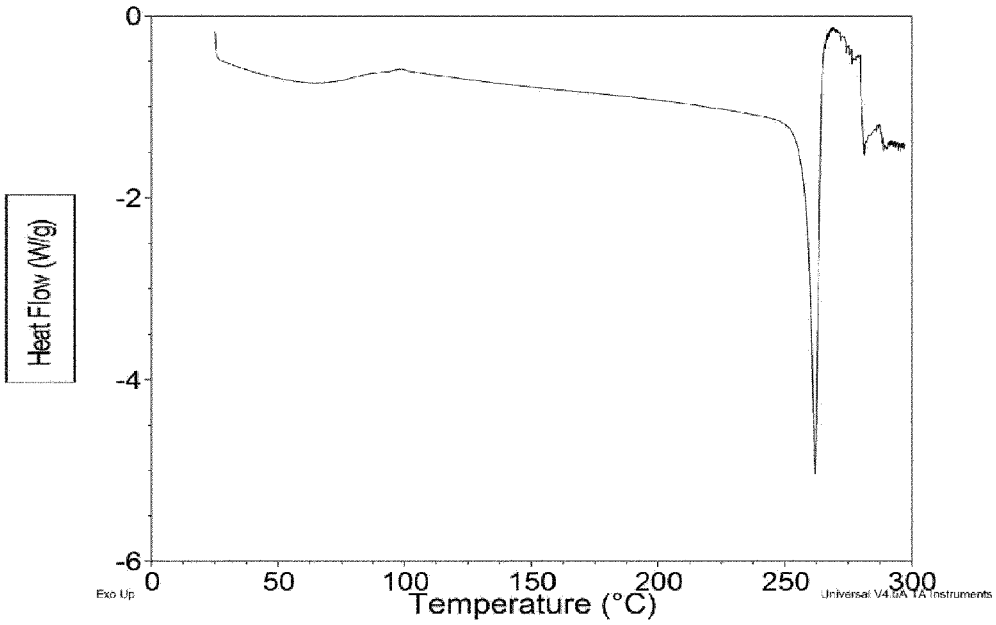

**Figure 20: X-Ray Powder Diffraction Pattern *N*-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Mesylate salt - Form B**

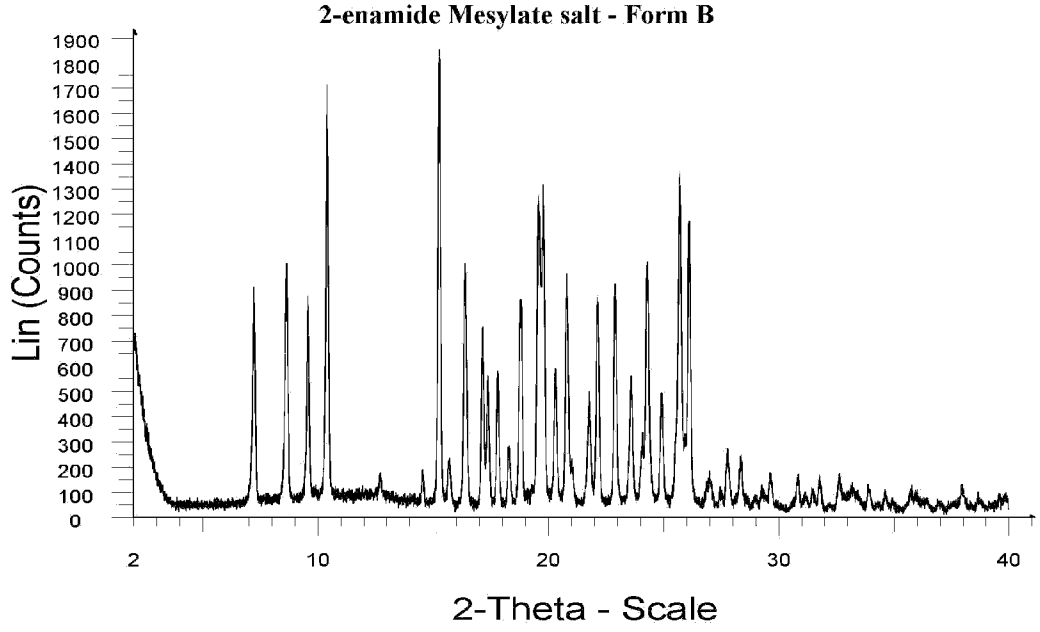

**Figure 21: DSC Thermogram N-(2-{2-dimethylaminoethyl-methylamino}-4-methoxy-5-{[4-(1-methylindol-3-yl)pyrimidin-2-yl]amino}phenyl)prop-2-enamide Mesylate salt - Form B**