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(54) **Title:** CRYSTALLINE FORM OF A SUBSTITUTED QUINOLINE COMPOUND AND PHARMACEUTICAL COMPOSITIONS THEREOF

(57) **Abstract:** The present invention relates to a crystalline form of *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide *p*-toluenesulfonate, the process for preparing the crystalline form thereof, and the pharmaceutical compositions comprising the crystalline form thereof. This invention also relates to a method of using such a crystalline form and pharmaceutical compositions comprising the crystalline form thereof in the treatment of hyperproliferative diseases in mammals, especially in humans.

CRYSTALLINE FORM OF A SUBSTITUTED QUINOLINE COMPOUND AND PHARMACEUTICAL COMPOSITIONS THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/255,391, filed on November 14, 2015, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] This invention relates to a crystalline form of *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide *p*-toluenesulfonate, the process for preparing the crystalline form thereof, and pharmaceutical compositions comprising the crystalline form, and pharmaceutical compositions comprising the crystalline form thereof. This invention also relates to a method of using such a crystalline form in the treatment of hyperproliferative diseases in mammals, especially in humans.

BACKGROUND OF THE INVENTION

[0003] Traditionally, dramatic improvements in the treatment of cancer are associated with identification of therapeutic agents acting through novel mechanisms. One mechanism that has been exploited in cancer treatment is the modulation of protein kinase activity, because signal transduction through protein kinase activation is responsible for many of the characteristics of tumor cells. Protein kinase signal transduction is of particular relevance in, for example, thyroid, gastric, kidney, brain, head and neck, lung, breast, prostate and colorectal cancers, as well as in the growth and proliferation of brain tumor cells, among many other solid and blood cancers.

[0004] Protein kinases can be categorized as receptor type or non-receptor type. Receptor-type tyrosine kinases generally comprise of a transmembrane receptors with diverse biological activities. For a detailed discussion of the receptor-type tyrosine kinases, see “Structural biology of protein tyrosine kinases”, *Cell. Mol. Life Sci.*, **2006** (63), 2608–2625. Since kinases and their ligands play critical roles in various cellular activities, dysregulation of protein kinase activity

can lead to altered cellular properties, such as uncontrolled cell growth associated with cancer. Therefore, protein kinases are attractive targets for small molecule drug discovery. Particularly attractive targets for small-molecule modulation with respect to antiangiogenic and antiproliferative activity include receptor tyrosine kinases such as VEGFRs, Flt3, c-Met, Axl and Mer, among many others.

[0005] Angiogenesis, the formation of new capillaries from preexisting blood vessels, is a necessary process for organ development during embryogenesis and is critical for the female reproductive cycle, inflammation, and wound healing in the adult. Certain diseases are known to be associated with dysregulated angiogenesis, for example ocular neovascularization, such as retinopathies (including diabetic retinopathy), age-related macular degeneration, fibrosis, psoriasis, hemangioblastoma, hemangioma, arteriosclerosis, inflammatory disease, such as a rheumatoid or rheumatic inflammatory disease, especially arthritis (including rheumatoid arthritis), or other chronic inflammatory disorders, such as chronic asthma, arterial or post-transplantational atherosclerosis, endometriosis, and neoplastic diseases, for example so-called solid tumors and liquid tumors (such as leukemias). Solid tumors, in particular, are dependent on angiogenesis to grow beyond a certain critical size by inducing new capillaries sprouting from existing blood vessels to secure their nutrition, oxygen supply, and waste removal. In addition, angiogenesis also promotes metastasis of tumor cells to other sites.

[0006] The new vessel growth and maturation are highly complex and coordinated processes, requiring the stimulation by a number of growth factors. Vascular endothelial growth factor (VEGF) signaling often represents a critical rate-limiting step in physiological and pathological angiogenesis. VEGF binds to and activates the receptor tyrosine kinase, VEGFR. Three VEGFR isoforms have been identified in humans: VEGFR-1 (Flt-1), VEGFR-2 (KDR/Flk-1) and VEGFR-3 (Flt-4). VEGFR-2 mediates the majority of cellular responses to VEGF, in particular its mitogenic and angiogenic effects. VEGFR-1 is thought to modulate VEGFR-2 signaling or to act as a dummy/decoy receptor to sequester VEGF away from VEGFR-2. (Stuttfeld E, Ballmer-Hofer K (2009). "Structure and function of VEGF receptors". *IUBMB Life* 61 (9): 915–22).

[0007] Since VEGFR-2 is the major mediator of vascular endothelial cell (EC) mitogenesis and survival, as well as angiogenesis and microvascular permeability, it is expected that direct inhibition of the kinase activity of VEGFR-2 will result in the reduction of angiogenesis and the suppression of tumor growth. Furthermore, inhibition of VEGFR-2 targeting the genetically more stable host endothelial cells, instead of labile tumor tissues, may decrease the chance of resistance development. Several agents targeting VEGFR signaling, administered either as single agents or in combination with chemotherapy, have been shown to benefit patients with advanced-stage malignancies. (“VEGF-targeted therapy: mechanisms of anti-tumor activity.” *Nature Reviews Cancer*, **2008**, 8, 579; “Molecular basis for sunitinib efficacy and future clinical development.” *Nature Reviews Drug Discovery*, **2007**, 6, 734; “Angiogenesis: an organizing principle for drug discovery?” *Nature Reviews Drug Discovery*, **2007**, 6, 273).

[0008] FLT3 (Flt3, FMS-related tyrosine kinase 3), also known as FLK-2 (fetal liver kinase 2) and STK-1 (human stem cell kinase 1), belongs to a member of the class III receptor tyrosine kinase (RTK-III) family that include KIT, PDGFR, FMS and FLT1 (Stirewalt DL, et al., *Nat. Rev. Cancer*, **2003**, 3:650-665). FLT3 has been implicated in hematopoietic disorders which are pre-malignant disorders including myeloproliferative disorders, such as thrombocythemia, essential thrombocytosis (ET), myelofibrosis (MF), chronic idiopathic myelofibrosis (IMF), and polycythemia vera (PV), pre-malignant myelodysplastic syndromes. Hematological malignancies include leukemias, lymphomas (non-Hodgkin's lymphoma), Hodgkin's disease (also called Hodgkin's lymphoma), and myeloma, for instance, acute lymphocytic leukemia (ALL), acute myeloid leukemia (AML), acute promyelocytic leukemia (APL), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), chronic neutrophilic leukemia (CNL) (Matthew C. Stubbs and Scott A. Armstrong, “FLT3 as a Therapeutic Target in Childhood Acute Leukemia.” *Current Drug Targets*, **2007**, 8, 703-714).

[0009] FLT3 is overexpressed at the levels in 70-100% of cases of acute myeloid leukemias (AML), and in a high percentage of T-acute lymphocytic leukemia (ALL) cases (Griffin JD, et al., *Haematol J*, **2004**, 5: 188-190). It is also overexpressed in a smaller subset of chronic myeloid leukemia (CML) in blast crisis. Studies have shown that the leukemic cells of B lineage ALL and

AML frequently co-express FL, setting up autocrine or paracrine signaling loops that result in the constitutive activation of FLT3 (Zheng R, et. al., *Blood.*, 2004, 103: 267-274). A high level of the FLT3 ligand is found in the serum of patients with Langerhans cell histiocytosis and systemic lupus erythematosus, which further implicates FLT3 signaling in the dysregulation of dendritic cell progenitors in those autoimmune diseases (Rolland et al., *J. Immunol.*, 2005, 174:3067-3071; Engen et al., “Targeted Therapy of FLT3 in Treatment of AML—Current Status and Future Directions.” *J. Clin. Med.*, 2014, 3, 1466-1489).

[0010] c-Met, also referred to as hepatocyte growth factor receptor (HGFR), is expressed predominantly in epithelial cells but has also been identified in endothelial cells, myoblasts, hematopoietic cells and motor neurons. The natural ligand for c-Met is hepatocyte growth factor (HGF), also known as scatter factor (SF). In both embryos and adults, activated c-Met promotes a morphogenetic program, known as invasive growth, which induces cell spreading, the disruption of intercellular contacts, and the migration of cells towards their surroundings. (“From Tpr-Met to Met, tumorigenesis and tubes.” *Oncogene*, 2007, 26, 1276; “Met Receptor Tyrosine Kinase as a Therapeutic Anticancer Target.” *Cancer Letter*, 2009, 280, 1-14).

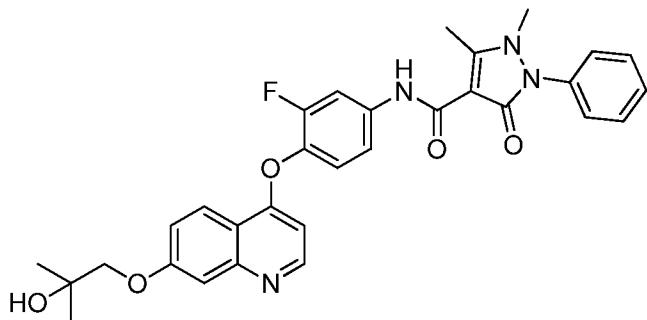
[0011] A wide variety of human malignancies exhibit sustained c-Met stimulation, overexpression, or mutation, including carcinomas of the breast, liver, lung, ovary, kidney, thyroid, colon, renal, glioblastomas, and prostate, etc. c-Met is also implicated in atherosclerosis and organ fibrosis such as lung fibrosis. Invasive growth of certain cancer cells is drastically enhanced by tumor-stromal interactions involving the HGF/c-Met pathway. Thus, extensive evidence that c-Met signaling is involved in the progression and spread of several cancers has generated considerable interest in c-Met as major targets in cancer drug development. (“Molecular cancer therapy: can our expectation be MET.” *Euro. J. Cancer*, 2008, 44, 641-651; “Targeting the c-Met Signaling Pathway in Cancer.” *Clin. Cancer Res.*, 2006, 12, 3657). Agents targeting c-Met signaling pathway are now under clinical investigation. (“Novel Therapeutic Inhibitors of the c-Met Signaling Pathway in Cancer.” *Clinical Cancer Research*, 2009, 15, 2207; “Drug development of MET inhibitors: targeting oncogene addiction and expedience.” *Nature Review Drug Discovery*, 2008, 7, 504).

[0012] The TYRO3, AXL (also known as UFO) and MERTK (also known as Mer) (TAM) family of receptor tyrosine kinases (RTKs) was one of the latest to evolve. Members of this

family have a similar overall domain structure and are highly related by a unique KWIAIES conserved sequence in their kinase domain. TAM RTKs are ectopically expressed or overexpressed in a wide variety of human cancers in which they provide tumor cells with a survival advantage. In experimental models, Axl and MerTK can be oncogenic. Although MerTK and Axl can activate standard proliferative pathways (ERK, AKT and members of the signal transducer and activator of transcription (STAT) family), their output generally promotes survival rather than proliferation. These kinases are potentially dual anticancer targets, firstly in tumor cells that have developed a non-oncogene addiction to TAM RTK survival signals and secondly in the microenvironment where MerTK and Axl inhibition may reverse innate immune suppression. (“The TAM family: phosphatidylserine-sensing receptor tyrosine kinases gone awry in cancer.” *Nature Review Cancer*, **2014**, *14*, 769)

[0013] Recently a study showed that Mer and Axl were frequently overexpressed and activated in many tumor cell lines, such as in various NSCLC cell lines. Ligand-dependent Mer or Axl activation stimulated MAPK, AKT and FAK signaling pathways indicating roles for these RTKs in multiple oncogenic processes. Abnormal expression and activation of Axl knockdown also improved in vitro NSCLC sensitivity to chemotherapeutic agents by promoting apoptosis. When comparing the effects of Mer and Axl knockdown, Mer inhibition exhibited more complete blockade of tumor growth while Axl knockdown more robustly improved chemosensitivity. Therefore, inhibition of Axl, Mer or both is potentially a therapeutic strategy to target cancer cells (Rachel et al., “Mer or Axl Receptor Tyrosine Kinase inhibition promotes apoptosis, blocks growth, and enhances chemosensitivity of human non-small cell lung cancer” *Oncogene*, **2013**, *32*(29), 3420-3431).

[0014] Accordingly, small-molecule compounds that specially inhibit, regulate and/ or modulate the signal transduction of kinases, particularly including VEGFRs, Flt3, c-Met, Axl and Mer as described above, are desirable as a means to treat or prevent disease states associated with abnormal cell proliferation and angiogenesis. One such small-molecule is *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide, which has the chemical structure as shown in the following:



[0015] WO 2012118632 A1 described the synthesis of *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide (Example 1), the salts thereof, such as hydrochloride (Example 5), maleate (Example 6), *p*-toluenesulfonate (Example 7), and benzene sulfonate (Example 8), and also disclosed the therapeutic activity of these molecules and salts thereof in inhibiting, regulating and modulating the signal transduction of protein kinases.

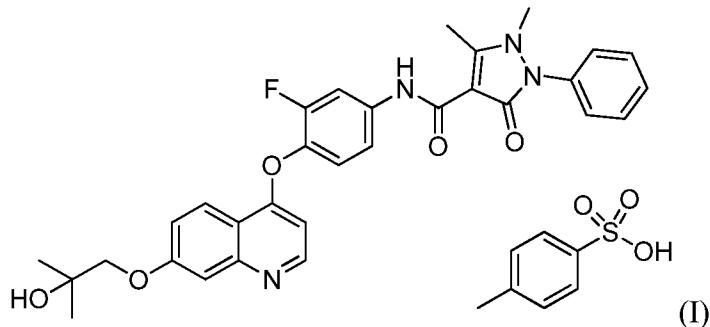
[0016] Different salts and solid state form of an active pharmaceutical ingredient may possess different properties. Such variations in the properties of different salts and solid state forms may provide a basis for improving formulation, for example, by facilitating better processing or handling characteristics, improving the dissolution profile, stability (polymorph as well as chemical stability) and shelf-life. These variations in the properties of different salts and solid state forms may also provide improvements to the final dosage form, for example, if they serve to improve bioavailability. Different salts and solid state forms of an active pharmaceutical ingredient may also give rise to a variety of polymorphs or crystalline forms, which may in turn provide additional opportunities to assess variations in the properties and characteristics of a solid active pharmaceutical ingredient.

SUMMARY OF THE INVENTION

[0017] The present invention provides a crystalline form of *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide *p*-toluenesulfonate, and novel pharmaceutical compositions containing the crystalline form thereof. The invention also encompasses the therapeutic uses of the crystalline form described herein and the therapeutic compositions

containing the crystalline form described herein. The techniques used to characterize the crystalline form are described in the examples herein. These techniques, alone or in combination, may be used to characterize the crystalline form disclosed herein. The crystalline form may be also characterized by reference to the figures disclosed herein.

[0018] In one aspect, provided herein is a crystalline form of the compound of formula (I):



wherein the crystalline form is form A having:

- a) an X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at about 8.29° , about 9.53° , about 11.11° , about 16.99° , about 18.75° and about 23.66° ; or
- b) an X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at $8.29^\circ \pm 0.2^\circ$, $9.53^\circ \pm 0.2^\circ$, $11.11^\circ \pm 0.2^\circ$, $16.99^\circ \pm 0.2^\circ$, $18.75^\circ \pm 0.2^\circ$ and $23.66^\circ \pm 0.2^\circ$; or
- c) unit cell parameters equal to or substantially equal to the following:
 - (i) unit cell dimensions: $a = 8.7430 \text{ \AA}$, $b = 12.8275 \text{ \AA}$, $c = 16.1281 \text{ \AA}$, $\alpha = 96.689^\circ$, $\beta = 95.737^\circ$, $\gamma = 99.649^\circ$;
 - (ii) space group: P-1;
 - (iii) volume: 1757.82 \AA^3 ;
 - (iv) Z : 2; and
 - (v) calculated density: 1.377 g/cm^3 .

[0019] In another embodiment, the crystalline form A has an X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at about 8.29° , about 9.53° , about 11.11° , about 15.28° , about 16.99° , about 18.75° , about 19.14° , about 19.98° , about 20.42° , about 21.77° , about 22.02° and about 23.66° ; or at $8.29^\circ \pm 0.2^\circ$, $9.53^\circ \pm 0.2^\circ$, $11.11^\circ \pm 0.2^\circ$, $15.28^\circ \pm 0.2^\circ$, $16.99^\circ \pm 0.2^\circ$, 18.75°

$\pm 0.2^\circ$, $19.14^\circ \pm 0.2^\circ$, $19.98^\circ \pm 0.2^\circ$, $20.42^\circ \pm 0.2^\circ$, $21.77^\circ \pm 0.2^\circ$, $22.02^\circ \pm 0.2^\circ$ and $23.66^\circ \pm 0.2^\circ$.

[0020] In another embodiment, the crystalline form A has an X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at about 8.29° , about 9.53° , about 11.11° , about 12.67° , about 14.04° , about 15.28° , about 15.82° , about 16.99° , about 18.75° , about 19.14° , about 19.98° , about 20.42° , about 21.77° , about 22.02° , about 22.45° , about 22.65° , about 23.66° , about 26.85° , about 27.94° and about 28.34° ; or at $8.29^\circ \pm 0.2^\circ$, $9.53^\circ \pm 0.2^\circ$, $11.11^\circ \pm 0.2^\circ$, $12.67^\circ \pm 0.2^\circ$, $14.04^\circ \pm 0.2^\circ$, $15.28^\circ \pm 0.2^\circ$, $15.82^\circ \pm 0.2^\circ$, $16.99^\circ \pm 0.2^\circ$, $18.75^\circ \pm 0.2^\circ$, $19.14^\circ \pm 0.2^\circ$, $19.98^\circ \pm 0.2^\circ$, $20.42^\circ \pm 0.2^\circ$, $21.77^\circ \pm 0.2^\circ$, $22.02^\circ \pm 0.2^\circ$, $22.45^\circ \pm 0.2^\circ$, $22.65^\circ \pm 0.2^\circ$, $23.66^\circ \pm 0.2^\circ$, $26.85^\circ \pm 0.2^\circ$, $27.94^\circ \pm 0.2^\circ$ and $28.34^\circ \pm 0.2^\circ$.

[0021] In another embodiment, the crystalline form A has an X-ray powder diffraction pattern is substantially in accordance with that shown in Figure 2.

[0022] In one embodiment, the crystalline form A has a differential scanning calorimetry trace comprising a maximum in endothermic heat flow at $219\text{ }^\circ\text{C} \pm 3\text{ }^\circ\text{C}$.

[0023] In another embodiment, the crystalline form A has a differential scanning calorimetry trace substantially in accordance with that shown in Figure 3.

[0024] In one embodiment, the crystalline form A has a thermal gravimetric analysis curve comprising a weight loss of about 0.23% when heated to about $150\text{ }^\circ\text{C}$.

[0025] In another embodiment, the crystalline form A has a thermal gravimetric analysis curve substantially in accordance with that shown in Figure 4.

[0026] In another embodiment, the crystalline form is substantially pure.

[0027] In another aspect, provided herein is a pharmaceutical composition comprising the crystalline form A.

[0028] In one embodiment, the composition further comprises a pharmaceutically acceptable excipient, carrier, vehicle or a combination thereof.

[0029] In another embodiment, the pharmaceutical composition further comprises a therapeutic

agent, In further embodiments, the therapeutic agent is melphalan, cyclophosphamide, ifosfamide, busulfan, carmustine, lomustine, streptozocin, cisplatin, carboplatin, oxaliplatin, dacarbazine, temozolomide, procarbazine, methotrexate, fluorouracil, cytarabine, gemcitabine, mercaptopurine, fludarabine, vinblastine, vincristine, vinorelbine, paclitaxel, docetaxel, topotecan, irinotecan, etoposide, trabectedin, dactinomycin, doxorubicin, epirubicin, daunorubicin, mitoxantrone, bleomycin, mitomycin, ixabepilone, tamoxifen, flutamide, gonadorelin analogues, megestrol, prednisone, dexamethasone, methylprednisolone, thalidomide, interferon alfa, leucovorin, sirolimus, temsirolimus, everolimus, afatinib, alisertib, amuvatinib, apatinib, axitinib, bosutinib, bortezomib, brivanib, cediranib, cabozantinib, crenolanib, crizotinib, dabrafenib, dacitinib, danusertib, dasatinib, dovitinib, erlotinib, foretinib, ganetespib, gefitinib, ibrutinib, icotinib, imatinib, iniparib, lapatinib, lenvatinib, linifanib, linsitinib, masitinib, momelotinib, neratinib, nilotinib, niraparib, oprozomib, olaparib, pazopanib, pegaptanib, pictilisib, ponatinib, quizartinib, radotinib, regorafenib, rigosertib, rucaparib, ruxolitinib, saracatinib, saridegib, sorafenib, sunitinib, tasocitinib, telatinib, tivantinib, tivozanib, tofacitinib, trametinib, vandetanib, veliparib, vemurafenib, vismodegib, volasertib, alemtuzumab, bevacizumab, brentuximab vedotin, catumaxomab, cetuximab, denosumab, gemtuzumab, ipilimumab, nimotuzumab, ofatumumab, panitumumab, ramucirumab, rituximab, tositumomab, trastuzumab, idelalisib, duvelisib, gilteritinib, buparlisib, taselisib, copanlisib, voxtalisib, pilaralisib, sonolisib, perifosine, alectinib, ibrutinib, pertuzumab, nintedanib, cobimetinib, temsirolimus, sirolimus, pixantrone or a combination thereof.

[0030] In another aspect, provided herein is a method of preventing, treating or lessening the severity of a proliferative disorder in a patient by administering to the patient with the crystalline form A disclosed herein or the pharmaceutical composition disclosed herein.

[0031] In one embodiment, wherein the proliferative disorder is colon cancer, rectal cancer, gastric cancer, gastric adenocarcinoma, pancreatic cancer, bladder cancer, gallbladder cancer, breast cancer, kidney cancer, renal cell carcinoma, liver cancer, hepatocellular carcinoma, lung cancer, skin cancer, melanoma, thyroid cancer, osteosarcomas, soft tissue sarcoma, a cancer of the head and neck, a cancer of the central nervous system, glioma, glioblastomas, ovarian cancer,

uterine cancer, endometrial carcinoma, prostate cancer, acute myeloid leukemia or acute lymphoblastic leukemia, or a metastasis thereof.

[0032] In another aspect, provided herein is a method of inhibiting a receptor tyrosine kinase with the crystalline form A disclosed herein or the pharmaceutical composition disclosed herein, wherein the receptor tyrosine kinase is VEGFRs, Flt3, c-Met, Axl, Mer or a combination thereof.

[0033] In another aspect, provided herein is the use of the crystalline form A or the pharmaceutical composition disclosed herein in preventing, treating or lessening the severity of a proliferative disease in a patient.

[0034] In another aspect, provided herein is the use of the crystalline form A or the pharmaceutical composition disclosed herein in inhibiting or modulating a receptor tyrosine kinase, wherein the receptor tyrosine kinase is VEGFRs, Flt3, c-Met, Axl, Mer or a combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] Figure 1 depicts an X-ray single crystal diffraction pattern of the crystalline form A of the compound (I).

[0036] Figure 2 depicts an X-ray powder diffraction pattern of the crystalline form A of the compound (I).

[0037] Figure 3 depicts a differential scanning calorimetry thermogram of the crystalline form A of the compound (I).

[0038] Figure 4 depicts a thermal gravimetric analysis curve of the crystalline form A of the compound (I).

[0039] Figure 5 depicts a solid-state ^{13}C NMR spectra of the crystalline form A of the compound (I).

DETAILED DESCRIPTION OF THE INVENTION

DEFINITIONS AND GENERAL TERMINOLOGY

[0040] Reference will now be made in detail to certain embodiments of the invention, examples

of which are illustrated in the accompanying structures and formulas. The invention is intended to cover all alternatives, modifications, and equivalents which may be included within the scope of the present invention as defined by the claims. One skilled in the art will recognize many methods and materials similar or equivalent to those described herein, which could be used in the practice of the present invention. The present invention is in no way limited to the methods and materials described herein. In the event that one or more of the incorporated literature, patents, and similar materials differs from or contradicts this application, including but not limited to defined terms, term usage, described techniques, or the like, this application controls.

[0041] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by one skilled in the art to which this invention belongs. All patents and publications referred to herein are incorporated by reference in their entirety.

[0042] The term "comprising" is meant to be open ended, including the indicated component but not excluding other elements.

[0043] As used herein, a crystalline form that is "substantially pure" refers to a crystalline form that is substantially free of one or more other crystalline forms, *i.e.*, the crystalline form has a purity of at least about 60%, at least about 70%, at least about 80%, at least about 85%, at least about 90%, at least about 93%, at least about 95%, at least about 98%, at least about 99%, at least about 99.5%, at least about 99.6%, at least about 99.7%, at least about 99.8%, or at least about 99.9%; or the crystalline form has less than 20%, less than 10%, less than 5%, less than 3%, less than 1%, less than 0.5%, less than 0.1%, or less than 0.01% of the one or more other crystalline forms and/or impurities, based on the total volume or weight of the crystalline form and the one or more other crystalline forms and/or impurities.

[0044] As used herein, an X-ray powder diffraction (XRPD) pattern or a differential scanning calorimetry (DSC) thermogram that is "substantially the same as shown" in a figure refers to an X-ray powder diffraction (XRPD) pattern, a differential scanning calorimetry (DSC) thermogram or a thermal gravimetric analysis curve (TGA) having at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, at least 95%, or at least 99% of the peaks shown in the figure.

[0045] The term "2 theta value" or "2 θ " refers to the peak position in degrees based on the

experimental setup of the X-ray diffraction experiment and is a common abscissa unit in diffraction patterns. The experimental setup requires that if a reflection is diffracted when the incoming beam forms an angle theta (θ) with a certain lattice plane, the reflected beam is recorded at an angle 2 theta (2θ). It should be understood that reference herein to specific 2θ values for a specific polymorphic form is intended to mean the 2θ values (in degrees) as measured using the X-ray diffraction experimental conditions described herein.

[0046] The term “X-ray powder diffraction pattern” or “XPRD pattern” or “XRD pattern” refers to the experimentally observed diffractogram or parameters derived therefrom. Powder X-ray diffraction patterns are characterized by peak position (abscissa) and intensities (ordinate). In the area of X-ray powder diffraction (XRD), relative peak height of XRD pattern depends on many factors related to sample preparation and geometric shapes of the instrument, while peak position is relatively insensitive to experimental details. Therefore, in some embodiments, the crystalline compounds described herein characterized by XRD pattern with some peak positions, have essentially the same characteristics as XRD pattern provided in appended drawings of the present invention. According to the current state of the instrument for the experiment, the error margin in the scattering angle (2θ) of the diffraction peaks is in the range of $\pm 0.1^\circ$, $\pm 0.2^\circ$, $\pm 0.3^\circ$, $\pm 0.4^\circ$, or $\pm 0.5^\circ$. In some embodiments, the error margin is $\pm 0.2^\circ$.

[0047] In the area of differential scanning calorimetry (DSC), relative peak height of DSC trace depends on many factors related to sample preparation and geometric shapes of the instrument, while peak position is relatively insensitive to experiment details. Therefore, in some embodiments, the crystalline compounds disclosed herein characterized by DSC trace with some peak positions, have essentially the same characteristics as DSC trace provided in appended drawings of the present invention. According to the current state of the instrument for the experiment, the error margin in the melting peaks is in the range of $\pm 1^\circ\text{C}$, $\pm 2^\circ\text{C}$, $\pm 3^\circ\text{C}$, $\pm 4^\circ\text{C}$, or $\pm 5^\circ\text{C}$. In some embodiments, the error margin is $\pm 3^\circ\text{C}$.

[0048] The term “relative intensity” refers to the intensity of a peak with respect to the intensity of the strongest peak in the X-ray powder diffraction pattern which is regarded as 100%.

[0049] As used herein, when referring to a spectrum and/or to data presented in a graph, the

term “peak” refers to a feature that one skilled in the art would recognize as not attributable to background noise.

[0050] As used herein, all numbers disclosed herein are approximate values, regardless whether the word “about” is used in connection therewith. The value of each number may differ by 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 15% or 20%.

GENERAL PREPARATION METHODS AND DESCRIPTION OF CRYSTALLINE FORM A OF COMPOUND (I)

[0051] Crystalline forms may be prepared by a variety of methods including, but not limited to, for example, crystallization or recrystallization from a suitable solvent mixture; sublimation; growth from a melt; solid state transformation from another phase; crystallization from a supercritical fluid; and jet spraying. Techniques for crystallization or recrystallization of crystalline forms in a solvent mixture include, but are not limited to, for example, evaporation of the solvent; decreasing the temperature of the solvent mixture; crystal seeding of a supersaturated solvent mixture of the compound and/or salt thereof; freeze drying the solvent mixture; and adding anti-solvents (counter solvents) to the solvent mixture. High throughput crystallization techniques may be employed to prepare crystalline forms including polymorphs.

[0052] Crystals of drugs, including polymorphs, methods of preparation, and characterization of drug crystals are discussed in *Solid-State Chemistry of Drugs*, S. R. Byrn, R. R. Pfeiffer, and J. G. Stowell, 2nd Edition, SSCI, West Lafayette, Indiana (1999).

[0053] In a crystallization technique in which a solvent or solvents are employed, the solvent(s) are typically chosen based on one or more factors including, but not limited to, for example, solubility of the compound; crystallization technique utilized; and vapor pressure of the solvent. Combinations of solvents may be employed. For example, the compound may be solubilized in a first solvent to afford a solution, to which anti-solvent is then added to decrease the solubility of the compound in the solution, and precipitate to form crystals. An anti-solvent is a solvent in which a compound has low solubility.

[0054] Seed crystals may be added to any crystallization mixture to promote crystallization.

Seeding may be employed to control growth of a particular polymorph and/or to control the particle size distribution of the crystalline product. Accordingly, calculation of the amount of seeds needed depends on the size of the seed available and the desired size of an average product particle as described, for example, in “Programmed Cooling Batch Crystallizers”, J. W. Mullin and J. Nyvlt, *Chemical Engineering Science*, 1971, 26, 369-377. In general, seeds of small particle size are needed to effectively control the growth of crystals in the batch. Seeds of small particle size may be generated by sieving, milling or micronizing large crystals, or by microcrystallizing a solution. In the milling or micronizing of crystals, care should be taken to avoid changing crystallinity from the desired crystalline form (i.e., changing to an amorphous or other polymorphic form).

[0055] A cooled crystallization mixture may be filtered under vacuum and the isolated solid product may be washed with a suitable solvent, such as, for example, cold recrystallization solvent. After being washed, the product may be dried under a nitrogen or air purge to afford the desired crystalline form. The product may be analyzed by a suitable spectroscopic or analytical technique including, but not limited to, for example, differential scanning calorimetry (DSC); X-ray powder diffraction (XRD); and thermogravimetric analysis (TGA) to assure the crystalline form of the compound has been formed. The resulted crystalline form may be obtained in an amount greater than about 70 wt.% isolated yield, based on the weight of the compound originally employed in the crystallization procedure, and preferably greater than about 90 wt.% isolated yield.

[0056] The feature and advantages of this invention may be more readily understood by those of ordinary skill in the art upon reading the following detailed description. It is to be appreciated that certain features of the invention that are, for clarity reasons, described above and below in the context of separate embodiments, may also be combined to form a single embodiment. Conversely, various features of this disclosure that are, for brevity reasons, described in the context of a single embodiment, may also be combined so as to form sub-combinations thereof. The invention is further illustrated by the following examples, which are not to be construed as limiting the invention in scope or spirit to the specific procedures described in them.

[0057] ^1H NMR spectra were recorded with a Bruker 400 MHz or 600 MHz spectrometer at ambient temperature. Solid-state ^{13}C NMR spectra were recorded with a Bruker 100 MHz spectrometer at ambient temperature (from about 21 °C to about 25 °C) using TMS (0 ppm) as the reference standard. ^1H NMR spectra were obtained as CDCl_3 , $\text{DMSO-}d_6$, CD_3OD or d_6 -acetone solutions (reported in ppm), using TMS (0 ppm) or chloroform (7.25 ppm) as the reference standard. When peak multiplicities are reported, the following abbreviations are used: s (singlet), d (doublet), t (triplet), m (multiplet), br (broadened), dd (doublet of doublets), dt (doublet of triplets). Coupling constants J , when given, are reported in Hertz (Hz).

[0058] Low-resolution mass spectral (MS) data were generally determined on an Agilent 6120 Quadrupole HPLC-MS (Zorbax SB-C18, 2.1 × 30 mm, 3.5 micron, 6 minutes run, 0.6 mL/min flow rate, 5% to 95% (0.1% formic acid in CH_3CN) in (0.1% formic acid in H_2O)) with UV detection at 210 nm/254 nm and electrospray ionization mode (ESI).

EXAMPLES

[0059] The starting material *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide can be prepared according to WO 2012118632 A1, the content of which is incorporated herein by reference in its entirety.

[0060] Example 1 Preparation of *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide *p*-toluenesulfonic acid Crystalline Form A

[0061] A suspension of *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide (10 g, 17.97 mmol) in ethanol (36 mL) was stirred at ambient temperature for 30 minutes. A solution of 4-methylbenzenesulfonic acid hydrate (4.44 g, 23.36 mmol) in water (15 mL) was added to the above mixture slowly. The resulted suspension was allowed to dissolve by heating the mixture up to 60 ~ 70 °C. The solution was maintained at 60 ~ 70 °C with stirring for 30 minutes, then cooled down to room

temperature. White solid was precipitated from the solution. The mixture was stirred for an additional hour at room temperature. Water (129 mL) was added slowly and the mixture was continued to stir at room temperature for 3 hours. The solid was collected through filtration and dried at 55 °C for 24 hours. The title compound was obtained as a white solid.(12.50 g, 95.4%).

Solid-state $^{13}\text{CNMR}$ Peaks (101 MHz) δ (ppm): 167.83, 165.36, 162.39, 156.94, 152.86, 146.62, 144.28, 141.33, 134.26, 131.79, 128.33, 126.21, 124.21, 120.71, 115.77, 113.98, 108.33, 102.58, 101.68, 98.69, 73.39, 71.77, 33.94, 28.13, 25.54, 21.59, 12.66.

CHARACTERIZATION OF CRYSTALLINE FORM A OF COMPOUND (I)

1. Single Crystal X-ray Study for Crystalline Form A of Compound (I)

[0062] Data were collected on an Agilent Technologies Gemini A Ultra serial diffractometer using Cu K α radiation ($\lambda = 1.5418 \text{ \AA}$). Indexing and processing of the measured intensity data were carried out with CrysAlis PRO procedure.

[0063] The structure was solved by direct methods using SHELX-97 (Sheldrick, G. M. SHELXTL-97, Program for Crystal Structure Solution and Refinement; University of Gottingen: Gottingen, Germany, 1997). The derived atomic parameters (coordinates and temperature factors) were refined through full matrix least-squares. The function minimized in the refinements was $\sum_w (|F_o| - |F_c|)^2$. R is defined as $\sum ||F_o| - |F_c|| / \sum |F_o|$, while $R_w = [\sum_w (|F_o| - |F_c|)^2 / \sum_w |F_o|^2]^{1/2}$ where w is an appropriate weighting function based on errors in the observed intensities. Difference maps were examined at all stages of refinement. All non-hydrogen atoms were refined with anisotropic displacement parameters. The positions of hydrogen atoms of H1N and H2N were located in Fourier difference electron density maps. All the other hydrogen atoms were placed in calculated positions with fixed isotropic thermal parameters and included in the structure factor calculations in the final stage of full-matrix least-squares refinement. Simulated powder X-ray patterns were generated using Mercury procedure.

[0064] A single crystal, measuring $0.15 \times 0.15 \times 0.10$ millimeter, was selected for single crystal diffraction analysis. The selected crystal was affixed to a thin glass fiber with a small amount of a light baseline, and mounted on a Gemini A Ultra single crystal diffractometer (Agilent

Technologies).

[0065] Crystalline Form A of compound (I) was characterized by unit cell parameters approximately equal to those reported in Table 1 below. The unit cell parameters were measured at a temperature of about 150 K.

Table 1

$a = 8.7430 \text{ \AA}$
$b = 12.8275 \text{ \AA}$
$c = 16.1281 \text{ \AA}$
$\alpha = 96.689^\circ$
$\beta = 95.737^\circ$
$\gamma = 99.649^\circ$
Space group: triclinic, P-1
Molecules of compound (I)/unit cell: 2
Volume: 1757.82 \AA^3

[0066] The crystal structure belongs to the triclinic space group, P-1, with two formula units in the unit cell. The structure contains cations of *N*-(3-fluoro-4-((7-(2-hydroxy-2-methylpropoxy)quinolin-4-yl)oxy)phenyl)-1,5-dimethyl-3-oxo-2-phenyl-2,3-dihydro-1*H*-pyrazole-4-carboxamide, protonated at the quinoline nitrogen atom, and single ionized 4-methylbenzenesulfonic acid anions, in a 1:1 ratio. The fractional atomic coordinates of crystalline form A of Compound (I) are shown in Table 2 below.

Table 2 Fractional Atomic Coordinates for Form A of Compound (I)

Atom	X	Y	Z	Atom	X	Y	Z
C2	0.5272	0.29964	0.85952	C3	0.4900	0.39026	1.08321
H3	0.5525	0.4296	1.1303	C4	0.6807	0.34515	0.85669
H4A	0.7270	0.3354	0.8076	C5	0.5010	0.20524	0.72212
C6	0.5483	0.37614	1.00564	C7	0.6085	0.13132	0.57363
C8	0.7987	0.08549	0.18118	C9	0.4554	0.31653	0.93325
C10	0.2979	0.27469	0.93988	H10	0.2329	0.2378	0.8927
C11	1.0179	0.47384	0.70406	C12	0.7516	0.08320	0.33278
C13	0.8860	0.41817	0.65289	H13	0.8393	0.3511	0.6634

Atom	X	Y	Z	Atom	X	Y	Z
C14	0.7393	0.01709	0.47779	C15	1.0251	0.61723	0.62035
H15	1.0726	0.6840	0.6096	C16	0.5790	0.12024	0.71783
C17	0.2409	0.28816	1.01508	H17	0.1370	0.2602	1.0189
C18	0.5286	0.21710	0.57770	H18	0.5110	0.2498	0.5300
C19	0.7641	0.40543	0.92836	H19	0.8673	0.4374	0.9269
C20	0.8645	-0.06028	0.35355	C21	0.6330	0.08201	0.64526
H21	0.6850	0.0243	0.6439	C22	0.3379	0.34433	1.08766
C23	0.4753	0.25417	0.65136	H23	0.4227	0.3115	0.6533
C24	0.8236	0.46311	0.58568	H24	0.7350	0.4254	0.5515
C25	0.3501	0.39873	1.23684	H25A	0.2802	0.4300	1.2713
H25B	0.4312	0.4560	1.2271	C26	0.8911	0.56317	0.56868
C27	1.0888	0.57366	0.68721	H27	1.1785	0.6107	0.7208
C28	0.7844	0.01210	0.39206	C29	0.9285	-0.15003	0.38623
H29A	0.8832	-0.2156	0.3508	H29B	0.9036	-0.1548	0.4425
H29C	1.0399	-0.1376	0.3865	C30	0.4249	0.32056	1.28434
C31	1.0045	-0.06379	0.22520	H31A	1.0958	-0.0094	0.2417
H31B	0.9706	-0.0658	0.1665	H31C	1.0291	-0.1318	0.2352
C32	0.7150	0.01579	0.11359	H32	0.6675	-0.0526	0.1206
C33	0.8489	0.22221	0.09412	H33	0.8906	0.2921	0.0879
C34	0.7696	0.15344	0.02575	H34	0.7602	0.1763	-0.0269
C35	0.7037	0.05013	0.03511	H35	0.6517	0.0035	-0.0115
C36	0.8668	0.18798	0.17217	H36	0.9240	0.2335	0.2180
C37	0.5116	0.38292	1.36660	H37A	0.5667	0.3371	1.3963
H37B	0.4381	0.4086	1.4005	H37C	0.5848	0.4423	1.3547
C38	0.3038	0.22722	1.29917	H38A	0.2532	0.1892	1.2461
H38B	0.2274	0.2533	1.3308	H38C	0.3541	0.1801	1.3300
C39	0.8235	0.61250	0.49640	H39A	0.8898	0.6108	0.4525
H39B	0.8166	0.6851	0.5154	H39C	0.7211	0.5730	0.4753
F1	0.60284	0.07416	0.78789	H1N	0.764	0.4569	1.0457
H2N	0.642	0.1352	0.4555	N1	0.70057	0.41906	0.99945
N2	0.66072	0.09930	0.49696	N3	0.81788	0.05166	0.26272
N4	0.87982	-0.04003	0.27427	O1	1.01066	0.31527	0.78951

Atom	X	Y	Z	Atom	X	Y	Z
O2	1.26509	0.41912	0.77460	O3	1.09385	0.49307	0.86484
O4	0.53424	0.28353	1.23306	H4	0.5763	0.2401	1.2560
O5	0.26399	0.34925	1.15761	O6	0.43525	0.23418	0.79515
O7	0.77026	-0.04440	0.52721	O8	0.67736	0.15870	0.33835
S1	1.10469	0.41955	0.78939				

2. X-ray powder diffraction Study for Crystalline Form A of Compound (I)

[0067] The X-ray powder diffraction (XRPD) pattern was collected on an X-ray powder diffractometer (Empyrean, PANalytical, Holland) with an automatic transmission-reflection sample holder (3*15). The X-ray tube (Cu, $\text{K}\alpha$, $\text{K}\alpha 1$ (Å): 1.540598; $\text{K}\alpha 2$ (Å): 1.544426; $\text{K}\alpha 2/\text{K}\alpha 1 = 0.50$) is set to voltage at 45 kV and current at 40 mA, irradiated length = 10.0 mm. The scanning parameters were: continuous scan; range 3° to 40° ($2\theta \pm 0.2^\circ$); step size 0.0168° ; time per step 10 second. Data were collected at ambient temperature (from about 18 to about 30°C). Sample (usually 1~2 mg) was prepared as flat plate specimens by slightly pressed on a glass slide to obtain a flat surface. The data were collected by Data Collector software, and analyzed by Data Viewer and HighScore Plus software. The XRPD pattern for Compound (I), Form A is shown in Figure 2 and peaks and their related intensities in the XRPD pattern are shown in Table 3 below.

Table 3 Peaks in the XRPD pattern for Compound (I), Form A

Degrees [$^{\circ}2\theta$]	d-spacing [Å]	Rel. Int. [%]	degrees [$^{\circ}2\theta$]	d-spacing [Å]	Rel. Int. [%]
7.003	12.61193	6.60	8.2915	10.65514	49.66
9.5281	9.27484	64.99	10.124	8.73031	3.13
11.1054	7.96079	83.12	12.164	7.27047	2.01
12.666	6.98318	16.03	13.308	6.64800	1.54
14.042	6.30192	17.67	14.345	6.16924	14.55
15.2835	5.79266	24.86	15.821	5.59687	20.48
16.535	5.35698	16.38	16.675	5.31212	12.30
16.9895	5.21464	54.88	18.7504	4.72870	100.00

Degrees [°2θ]	d-spacing [Å]	Rel. Int. [%]	degrees [°2θ]	d-spacing [Å]	Rel. Int. [%]
19.1449	4.63213	45.26	19.798	4.48074	19.35
19.983	4.43972	35.24	20.4169	4.34633	42.34
21.117	4.20388	16.64	21.767	4.07967	32.79
22.0183	4.03370	43.66	22.454	3.95645	24.10
22.643	3.92383	23.59	23.163	3.83684	11.00
23.657	3.75793	50.67	24.260	3.66580	18.65
24.750	3.59440	8.96	25.053	3.55150	6.33
25.346	3.51115	13.11	26.477	3.36370	11.63
26.846	3.31830	19.49	27.935	3.19134	29.58
28.3406	3.14658	45.11	28.647	3.11365	11.40
28.8987	3.08707	48.13	29.462	3.02928	19.34
30.079	2.96855	3.75	31.576	2.83119	5.18
31.782	2.81325	12.05	32.669	2.73891	27.55
33.021	2.71048	5.73	33.491	2.67354	5.13
34.182	2.62107	6.29	34.548	2.59411	4.06
35.217	2.54632	2.24	35.588	2.52066	11.38
36.078	2.48751	5.15			

3. DSC of Crystalline Form A of Compound (I)

[0068] All DSC measurements were performed on a TA InstrumentsTM model Q2000 differential scanning calorimeter. The sample (about 2~6 mg) was weighted in an aluminum pan and recorded to a hundredth of a milligram, and transfer to the DSC instrument. The instrument was purged with nitrogen gas at 50 mL/min. Data were collected between room temperature and 300 °C at the heating rate of 10 °C/min. The data was analyzed by TA Universal Analysis software.

4. TGA of Crystalline Form A of Compound (I)

[0069] All TGA scans were performed on TGA TA Q500 thermogravimetric analyzer. The

sample (about 10 ~30 mg) was placed in a platinum pan pre-tared. The weight of the sample was measured accurately and recorded to a thousandth of a milligram by the instrument. The furnace was purged with nitrogen gas at 60 mL/min. Data were collected between room temperature and 300 °C at the heating rate of 10 °C/min. The data was analyzed by TA Universal Analysis software.

5. Stability test

[0070] A sample of crystalline form A of compound (I) (100~200 mg) was placed on a watching glass in the form of a thin layer (thickness \leq 5 mm). The samples were exposed to the following conditions: high temperature (60 ± 2 °C) for 10 days; high humidity (25 ± 2 °C, $90\% \pm 5\%$ relative humidity) for 10 days; illumination condition (visible light $4500\text{lx} \pm 500\text{lx}$ with ultraviolet light not lower than $0.7 \text{ W}\cdot\text{h}/\text{m}^2$, 25 ± 2 °C, $60\% \pm 5\%$ relative humidity) for 10 days; and room temperature (30 ± 2 °C, $65\% \pm 5\%$ relative humidity) for 10 days, respectively. The impurity contents in the samples were determined at different time points (0, 5 and 10 days) by high performance liquid chromatography (HPLC), and the absorption peaks were normalized relative to the highest peak (corresponds to compound I) which is set to 100%. The instrument and conditions for HPLC are showed in Table 4 and the data are shown in Table 5.

Table 4

Instrument and reagent	Instrument: Agilent 1200 or 1260, One over one hundred thousand of electronic balance, Volumetric flask, 0.45 μm nylon membrane filter; Reagent: Acetonitrile (HPLC), Monopotassium phosphate (AR), Potassium hydroxide (AR), Water (Millipore).
Solution Preparation	Blank Solution/Diluent: Mix acetonitrile and water at the ratio of 45/55 (v/v); Sample Solution: Transfer about 33 mg of crystalline form A of compound (I), accurately weighed, to a 100 mL volumetric flask and add diluent to dissolve. Dilute to volume with Diluent and mix well.
Chromatographic Conditions	Column: Octadecyl silane bonded silica gel column, 4.6×150 mm, 5 μm ;

	Column temperature: 30 °C; Detection wavelength: 235 nm; Flow rate: 1.0 mL/min; Injection volume: 20 µL; Buffer solution: Dissolve 1.361 g of monopotassium phosphate in 1 L of water and mix well. Adjust with potassium hydroxide to a pH of 6.0. Filter the solution and sonicate to obtain buffer Solution; Mobile Phase: Mix Buffer and acetonitrile at the ratio of 55/45 (v/v); Run time: 30 min.
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Table 5

Condition		The impurity contents		
		0 day	5 days	10 days
Form A	high temperature	0.35%	0.37%	0.37%
	high humidity	0.35%	0.37%	0.39%
	illuminating condition	0.35%	0.38%	0.48%
	room temperature	0.35%	NT	NT
Amorphous	high temperature	0.14%	0.13%	0.10%
	high humidity	0.14%	0.11%	0.07%
	illuminating condition	0.14%	0.36%	0.56%
	room temperature	0.14%	0.07%	0.07%

NT: Not Test.

[0071] The results in Table 5 indicate that crystalline form A of Compound (I) and amorphous compound (I) were stable for at least 10 days under the condition of high temperature, high humidity and at room temperature. The impurity contents in crystalline form A of Compound (I) and amorphous Compound (I) form increased 0.13% and 0.42%, respectively, when illuminating the samples for 10 days.

6. Hygroscopicity test

[0072] A glass weighing bottle equipped with a stopper was tarred and the weight was recorded as m_1 . Compound (I) in crystalline form A or amorphous form (about 1.0 g) was placed in the tared weighing bottle and capped with the stopper. The total weight was then recorded as m_2 . The weighing bottle (without its stopper) was placed in a desiccator containing a saturated solution of ammonium chloride (80% \pm 2% RH (relative humidity)) at 25 \pm 1°C. The weighing bottle capped with its stopper was weighed on day 5 and day 10 and the weight was recorded as m_3 . The hygroscopic capacity was calculate according to the following formula and the results are listed in Table 6.

$$(\text{Hygroscopic capacity}) = \frac{m_3 - m_2}{m_2 - m_1} \times 100\%$$

Table 6

Standing time	Hygroscopic capacity % (90% \pm 5%RH)	
	Form A	amorphous
5 d	0.03	7.74
10 d	0.12	8.48

[0073] The results from the Table 6 indicate that the crystalline form A of compound (I) was not hygroscopic whereas amorphous Compound (I) was hygroscopic.

7. Pharmacokinetics Test

[0074] The pharmacokinetic properties of amorphous Compound (I) or the crystalline form A of Compound (I) disclosed herein are assessed in beagle dogs. The LC/MS/MS system used in the analysis consists of an Agilent 1200 Series vacuum degasser, binary pump, well-plate autosampler, thermostatted column compartment, the Agilent G6430 Triple Quadrupole Mass Spectrometer with an electrosprayionization (ESI) source. Quantitative analysis was carried out using MRM mode. The parameters for MRM transitions are in the Table A.

Table A

MRM	490.2 \rightarrow 383.1
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^

Fragmentor	230 V
CE	55 V
Drying Gas Temp	350 °C
Nebulize	0.28 MPa
Drying Gas Flow	10 L/min

[0075] An Agilent XDB-C18, 2.1 × 30 mm, 3.5 µM column was used for the analysis. 5 µL of the samples were injected. Analysis condition: The mobile phase was 0.1% formic acid in water (A) and 0.1% formic acid in methanol (B). The flow rate was 0.4 mL/min. And the gradient of Mobile phase was in the Table B.

Table B

Time	Gradient of Mobile Phase B
0.5 min	5%
1.0 min	95%
2.2 min	95%
2.3 min	5%
5.0 min	stop

[0076] Alternatively, an Agilent 6330 series LC/MS/MS spectrometer equipped with G1312A binary pumps, a G1367A autosampler and a G1314C UV detector were used in the analysis. An ESI source was used on the LC/MS/MS spectrometer. The analysis was done in positive ion mode as appropriate and the MRM transition for each analyte was optimized using standard solution. A Capcell MP-C18 100 × 4.6 mm I.D., 5 µM column (Phenomenex, Torrance, California, USA) was used during the analysis. The mobile phase was 5 mM ammonia acetate, 0.1% MeOH in water (A): 5 mM ammonia acetate, 0.1% MeOH in acetonitrile (B) (70/30, v/v). The flow rate was 0.6 mL/min. Column was maintained at ambient temperature. 20 µL of the samples were injected.

[0077] The capsule of the crystalline form A or the amorphous of Compound (I) mixed with adjuvants respectively was administered by gavage to beagle dogs in a dose of 7 or 10 mg/kg. The blood samples (0.3 mL) were drawn at 0.25, 0.5, 1.0, 2.0, 3.0, 4.0, 6.0, 8.0, 12 and 24 hour time points or 0.083, 0.25, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0 and 24 hour time points and centrifuged at 3,000 or 4000 rpm for 2 to 10 min. The plasma solutions were collected, and analyzed by

LC/MS/MS as described above. The pharmacokinetic parameters were calculated according to non-compartment model using WinNonlin procedure. The pharmacokinetic parameters are shown in Table 7.

Table 7 Pharmacokinetic profiles in beagle dogs

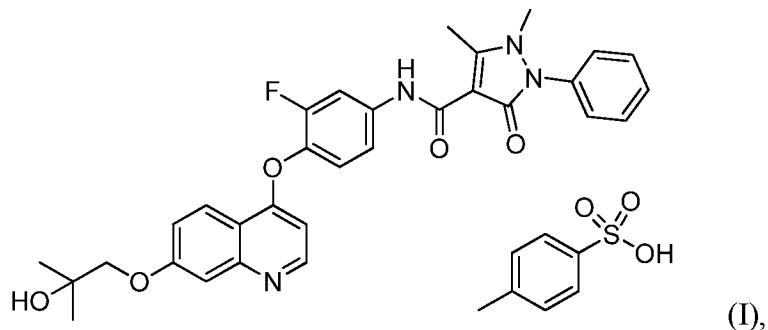
Example	Grain size D90(μm)	Dose (mg/kg)	T _{1/2} (h)	T _{max} (h)	C _{max} (ng/mL)	AUC _{0-24h} (ng.h/mL)	AUC _{0-∞} (ng.h/mL)
Form A	22	10	25.04	4.00	6194	130543	179557
Amorphous	32	9.7	15.05	3.33	2644	37282	55339

[0078] The results listed in Table 7 above show that the values of C_{max}, AUC_{0-24h} and AUC_{0-∞} of crystalline form A of Compound (I) are much larger than the amorphous Compound (I), which indicates that the crystalline form A of Compound (I) has a good exposure and bioavailability in vivo in beagle dogs.

[0079] The foregoing disclosure has been described in some detail by way of illustration and example, for purposes of clarity and understanding. The invention has been described with reference to various specific and preferred embodiments and techniques. However, it should be understood that many variations and modifications can be made while remaining within the spirit and scope of the invention. It will be obvious to one of skill in the art that changes and modifications can be practiced within the scope of the appended claims. Therefore, it is to be understood that the above description is intended to be illustrative and not restrictive. The scope of the invention should, therefore, be determined not with reference to the above description, but should instead be determined with reference to the following appended claims, along with the full scope of equivalents to which such claims are entitled.

WHAT IS CLAIMED IS:

1. A crystalline form of a compound of formula (I):



wherein the crystalline form is form A having:

- a) an X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at about 8.29° , about 9.53° , about 11.11° , about 16.99° , about 18.75° and about 23.66° ; or
- b) an X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at $8.29^\circ \pm 0.2^\circ$, $9.53^\circ \pm 0.2^\circ$, $11.11^\circ \pm 0.2^\circ$, $16.99^\circ \pm 0.2^\circ$, $18.75^\circ \pm 0.2^\circ$ and $23.66^\circ \pm 0.2^\circ$; or
- c) unit cell parameters substantially equal to the following:
 - (i) unit cell dimensions: $a = 8.7430 \text{ \AA}$, $b = 12.8275 \text{ \AA}$, $c = 16.1281 \text{ \AA}$, $\alpha = 96.689^\circ$, $\beta = 95.737^\circ$, $\gamma = 99.649^\circ$;
 - (ii) space group: P-1;
 - (iii) volume: 1757.82 \AA^3 ;
 - (iv) Z: 2; and
 - (v) calculated density: 1.377 g/cm^3 .

2. The crystalline form of claim 1 having an X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at about 8.29° , about 9.53° , about 11.11° , about 15.28° , about 16.99° , about 18.75° , about 19.14° , about 19.98° , about 20.42° , about 21.77° , about 22.02° and about 23.66° , or at $8.29^\circ \pm 0.2^\circ$, $9.53^\circ \pm 0.2^\circ$, $11.11^\circ \pm 0.2^\circ$, $15.28^\circ \pm 0.2^\circ$, $16.99^\circ \pm 0.2^\circ$, $18.75^\circ \pm 0.2^\circ$, $19.14^\circ \pm 0.2^\circ$, $19.98^\circ \pm 0.2^\circ$, $20.42^\circ \pm 0.2^\circ$, $21.77^\circ \pm 0.2^\circ$, $22.02^\circ \pm 0.2^\circ$ and $23.66^\circ \pm 0.2^\circ$.

3. The crystalline form of claim 1, wherein the X-ray powder diffraction pattern comprising peaks, in terms of 2θ , at about 8.29° , about 9.53° , about 11.11° , about 12.67° , about 14.04° , about 15.28° , about 15.82° , about 16.99° , about 18.75° , about 19.14° , about 19.98° , about 20.42° , about 21.77° , about 22.02° , about 22.45° , about 22.65° , about 23.66° , about 26.85° , about 27.94°

and about 28.34° , or at $8.29^\circ \pm 0.2^\circ$, $9.53^\circ \pm 0.2^\circ$, $11.11^\circ \pm 0.2^\circ$, $12.67^\circ \pm 0.2^\circ$, $14.04^\circ \pm 0.2^\circ$, $15.28^\circ \pm 0.2^\circ$, $15.82^\circ \pm 0.2^\circ$, $16.99^\circ \pm 0.2^\circ$, $18.75^\circ \pm 0.2^\circ$, $19.14^\circ \pm 0.2^\circ$, $19.98^\circ \pm 0.2^\circ$, $20.42^\circ \pm 0.2^\circ$, $21.77^\circ \pm 0.2^\circ$, $22.02^\circ \pm 0.2^\circ$, $22.45^\circ \pm 0.2^\circ$, $22.65^\circ \pm 0.2^\circ$, $23.66^\circ \pm 0.2^\circ$, $26.85^\circ \pm 0.2^\circ$, $27.94^\circ \pm 0.2^\circ$ and $28.34^\circ \pm 0.2^\circ$.

4. The crystalline form of claim 1, wherein the X-ray powder diffraction pattern is substantially in accordance with that shown in Figure 2.

5. The crystalline form of claim 1, wherein the crystalline form is substantially pure.

6. A pharmaceutical composition comprising the crystalline form of any one of claims 1 to 5 and a pharmaceutically acceptable excipient, carrier, vehicle or a combination thereof.

7. The pharmaceutical composition of claim 6 further comprising a therapeutic agent.

8. The pharmaceutical composition of claim 7, wherein the therapeutic agent is melphalan, cyclophosphamide, ifosfamide, busulfan, carmustine, lomustine, streptozocin, cisplatin, carboplatin, oxaliplatin, dacarbazine, temozolomide, procarbazine, methotrexate, fluorouracil, cytarabine, gemcitabine, mercaptopurine, fludarabine, vinblastine, vincristine, vinorelbine, paclitaxel, docetaxel, topotecan, irinotecan, etoposide, trabectedin, dactinomycin, doxorubicin, epirubicin, daunorubicin, mitoxantrone, bleomycin, mitomycin, ixabepilone, tamoxifen, flutamide, gonadorelin analogues, megestrol, prednisone, dexamethasone, methylprednisolone, thalidomide, interferon alfa, leucovorin, sirolimus, temsirolimus, everolimus, afatinib, alisertib, amuvatinib, apatinib, axitinib, bosutinib, bortezomib, brivanib, cediranib, cabozantinib, crenolanib, crizotinib, dabrafenib, dacotinib, danusertib, dasatinib, dovitinib, erlotinib, foretinib, ganetespib, gefitinib, ibrutinib, icotinib, imatinib, iniparib, lapatinib, lenvatinib, linifanib, linsitinib, masitinib, momelotinib, neratinib, nilotinib, niraparib, oprozomib, olaparib, pazopanib, pegaptanib, pictilisib, ponatinib, quizartinib, radotinib, regorafenib, rigosertib, rucaparib, ruxolitinib, saracatinib, saridegib, sorafenib, sunitinib, tasocitinib, telatinib, tivantinib, tivozanib, tofacitinib, trametinib, vandetanib, veliparib, vemurafenib, vismodegib, volasertib, alemtuzumab, bevacizumab, brentuximab vedotin, catumaxomab, cetuximab, denosumab, gemtuzumab, ipilimumab, nimotuzumab, ofatumumab, panitumumab, ramucirumab, rituximab, tositumomab, trastuzumab, idelalisib, duvelisib, gilteritinib, buparlisib, taselisib, copanlisib, voxtalisib, pilaralisib, sonolisib, perifosine, alectinib, ibrutinib, pertuzumab, nintedanib, cobimetinib, temsirolimus, sirolimus, pixantrone or a combination thereof.

9. A method of preventing, managing, treating or lessening the severity of a proliferative

disorder in a patient by administering to the patient with the crystalline form of any one of claims 1 to 5 or the pharmaceutical composition of any one of claims 6 to 8.

10. The method of claim 9, wherein the proliferative disorder is colon cancer, rectal cancer, gastric cancer, gastric adenocarcinoma, pancreatic cancer, bladder cancer, gallbladder cancer, breast cancer, kidney cancer, renal cell carcinoma, liver cancer, hepatocellular carcinoma, lung cancer, skin cancer, melanoma, thyroid cancer, osteosarcomas, soft tissue sarcoma, a cancer of the head and neck, a cancer of the central nervous system, glioma, glioblastomas, ovarian cancer, uterine cancer, endometrial carcinoma, prostate cancer, acute myeloid leukemia or acute lymphoblastic leukemia, or a metastasis thereof.

11. A method of inhibiting or modulating a receptor tyrosine kinase with the crystalline form of any one of claims 1 to 5 or the pharmaceutical composition of any one of claims 6 to 8, wherein the receptor tyrosine kinase is VEGFRs, Flt3, c-Met, Axl, Mer or a combination thereof.

12. The crystalline form of any one of claims 1 to 5 or the pharmaceutical composition of any one of claims 6 to 8 for use in preventing, treating or lessening the severity of a proliferative disease in a patient.

13. The crystalline form or pharmaceutical composition of claim 12, wherein the proliferative disorder is colon cancer, rectal cancer, gastric cancer, gastric adenocarcinoma, pancreatic cancer, bladder cancer, gallbladder cancer, breast cancer, kidney cancer, renal cell carcinoma, liver cancer, hepatocellular carcinoma, lung cancer, skin cancer, melanoma, thyroid cancer, osteosarcomas, soft tissue sarcoma, a cancer of the head and neck, a cancer of the central nervous system, glioma, glioblastomas, ovarian cancer, uterine cancer, endometrial carcinoma, prostate cancer, acute myeloid leukemia or acute lymphoblastic leukemia, or a metastasis thereof.

14. The crystalline form of any one of claims 1 to 5 or the pharmaceutical composition of any one of claims 6 to 8 for use in inhibiting or modulating a receptor tyrosine kinase, wherein the receptor tyrosine kinase is VEGFRs, Flt3, c-Met, Axl, Mer or a combination thereof.

15. Use of the crystalline form of any one of claims 1 to 5 or the pharmaceutical composition of any one of claims 6 to 8 in preventing, treating or lessening the severity of a proliferative disease in a patient.

16. The use of of claim 15, wherein the proliferative disorder is colon cancer, rectal cancer, gastric cancer, gastric adenocarcinoma, pancreatic cancer, bladder cancer, gallbladder cancer,

breast cancer, kidney cancer, renal cell carcinoma, liver cancer, hepatocellular carcinoma, lung cancer, skin cancer, melanoma, thyroid cancer, osteosarcomas, soft tissue sarcoma, a cancer of the head and neck, a cancer of the central nervous system, glioma, glioblastomas, ovarian cancer, uterine cancer, endometrial carcinoma, prostate cancer, acute myeloid leukemia or acute lymphoblastic leukemia, or a metastasis thereof.

17. Use of the crystalline form of any one of claims 1 to 5 or the pharmaceutical composition of any one of claims 6 to 8 in inhibiting or modulating a receptor tyrosine kinase, wherein the receptor tyrosine kinase is VEGFRs, Flt3, c-Met, Axl, Mer or a combination thereof.

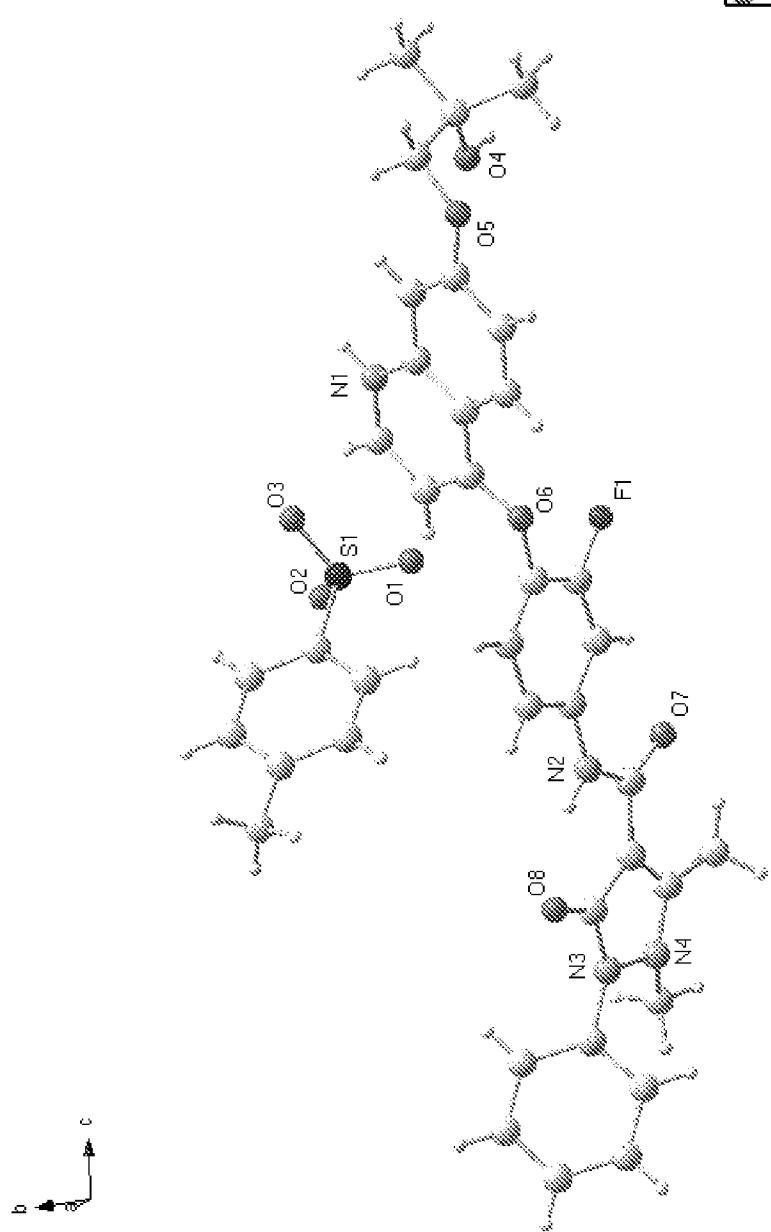
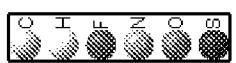


Figure 1

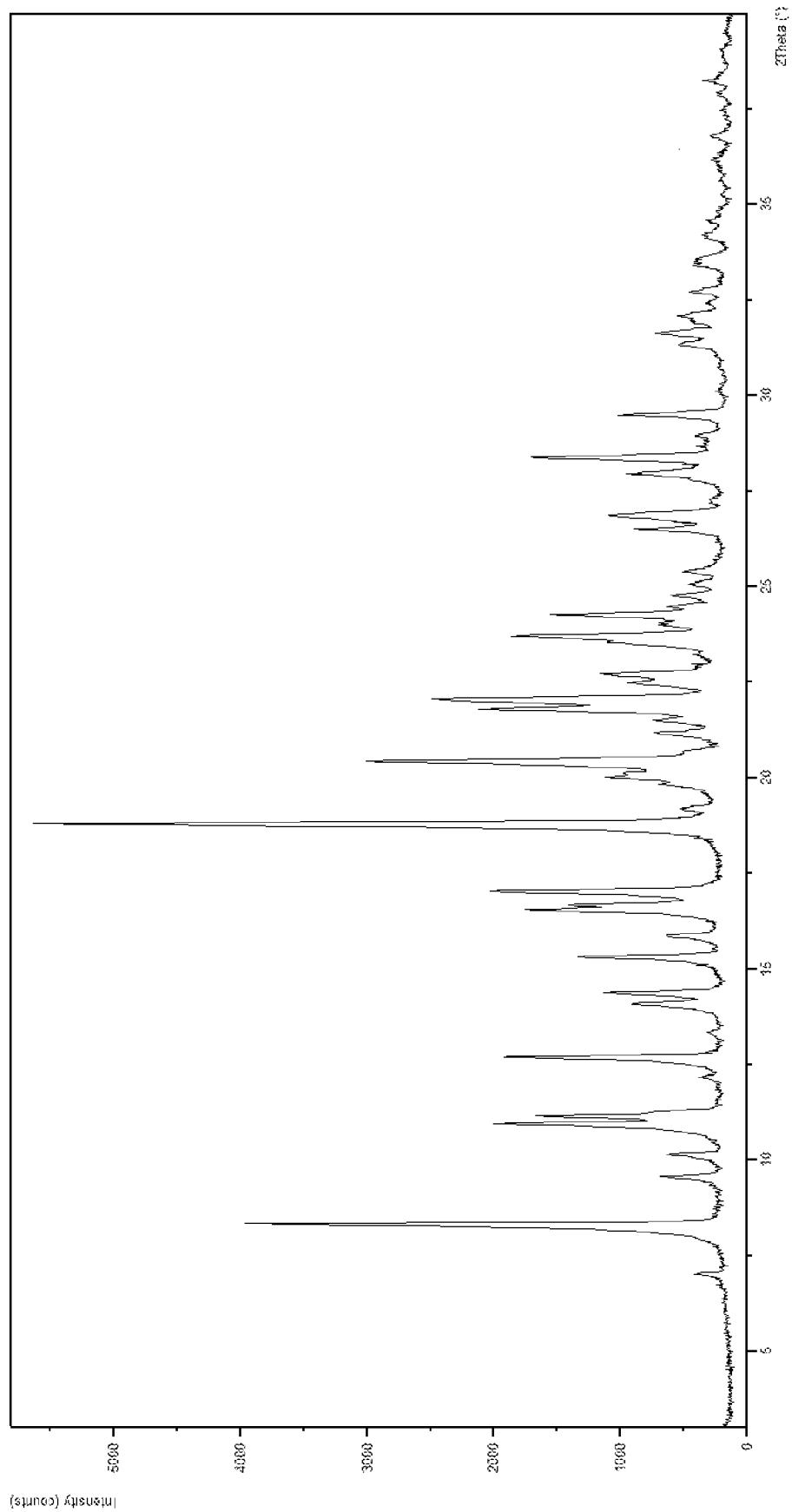


Figure 2

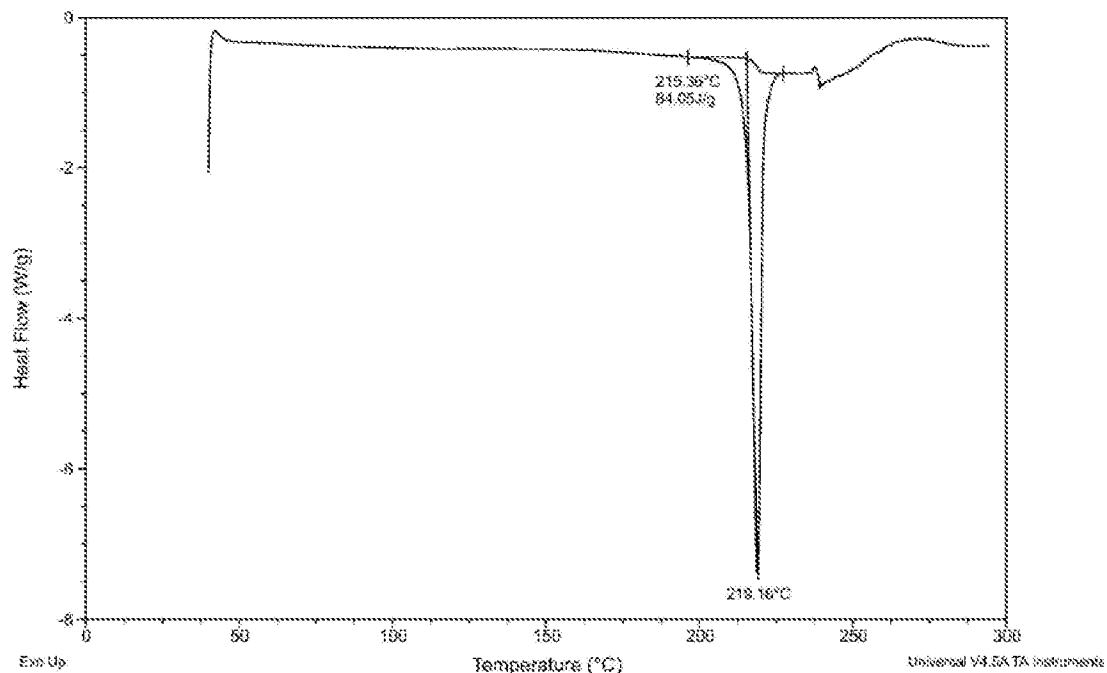


Figure 3

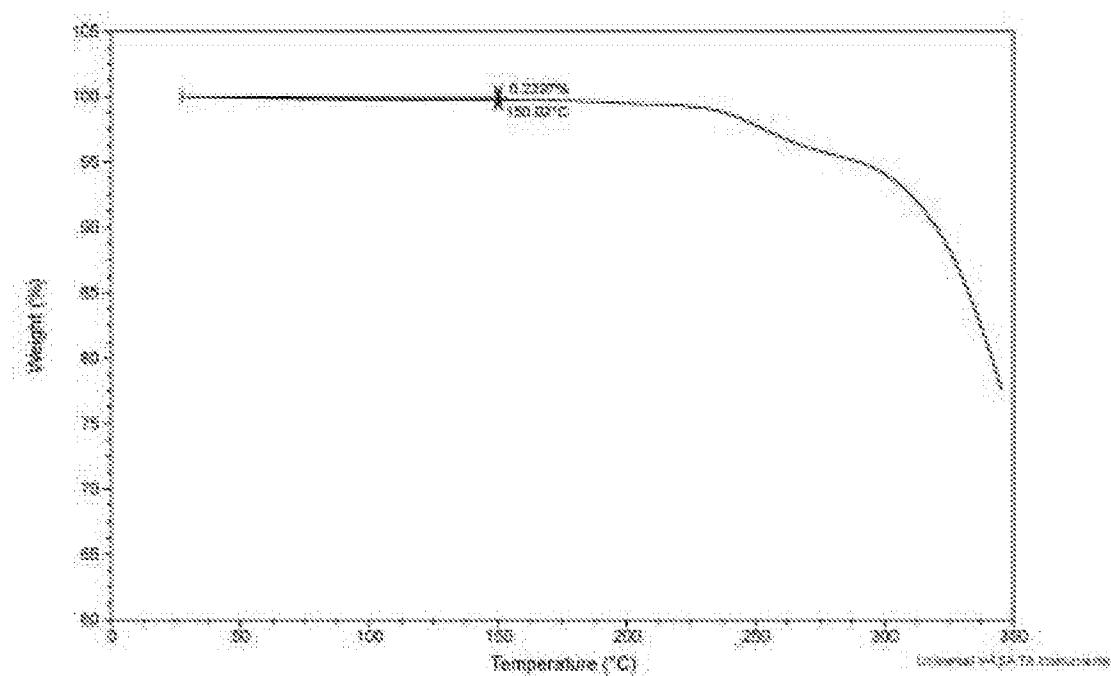


Figure 4

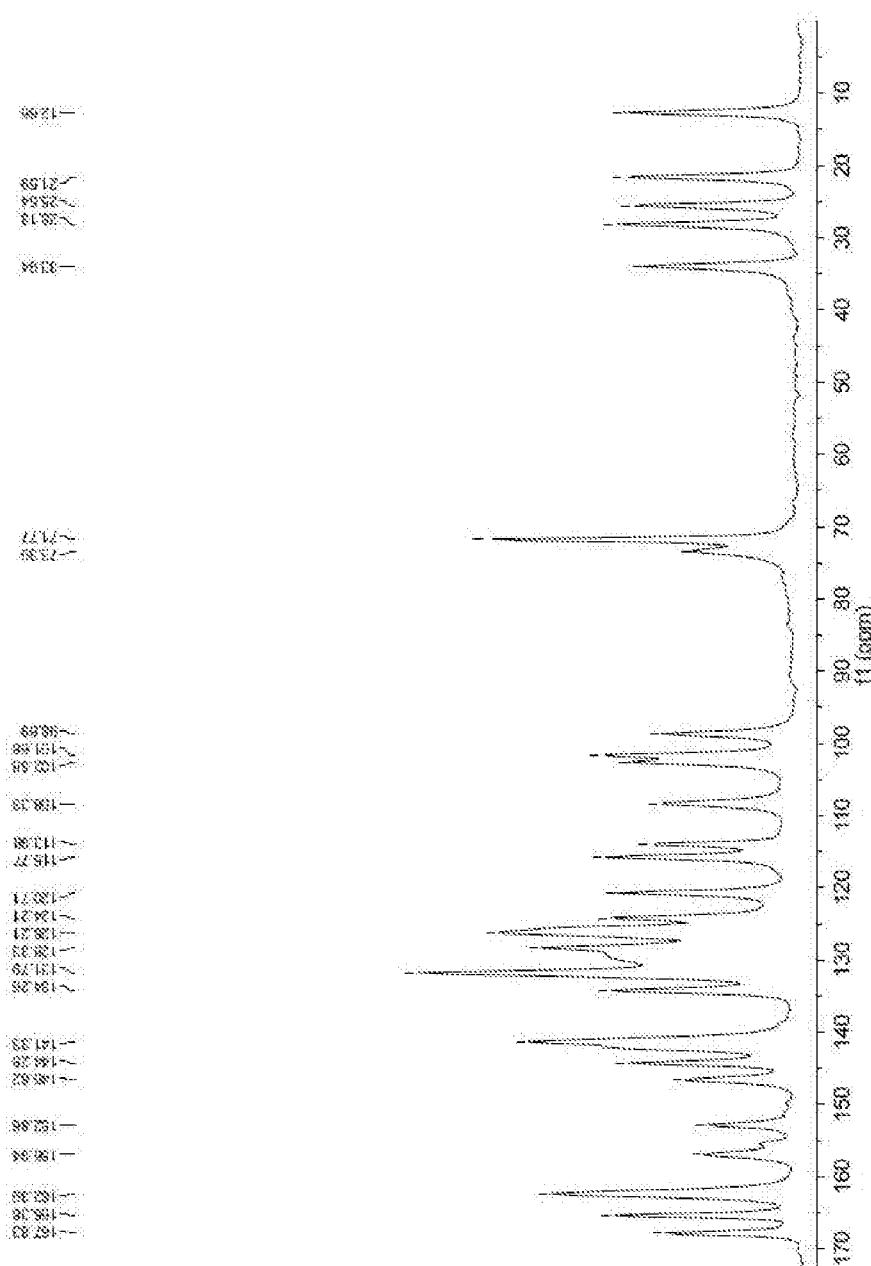


Figure 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/61717

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - A61K 31/436, A61K 31/4709, C07D 401/12, A61K 45/06, A61K 38/21 (2016.01)
 CPC - A61K 45/06, A61K 38/21, C07D 401/12, A61K 31/436, A61K 31/4709, A61K 2300/00
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC(8): A61K 31/436, A61K 31/4709, C07D 401/12, A61K 45/06, A61K 38/21 (2016.01)
 CPC: A61K 45/06, A61K 38/21, C07D 401/12, A61K 31/436, A61K 31/4709, A61K 2300/00

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 Thomson innovation (CA App, CA Grant, CN App, CN Grant, CN Util, DE App, DE Grant, DE Util, EP App, EP Grant, FR App, FR Grant, GB App, GB Grant, MX App, MX Grant, MY Grant, Other, SG App, SG Grant, TH Grant, US App, US Grant, VN App, VN Grant, WO App etc.), Google scholar, pubchem, surechem. Terms: pyrazole-4-carboxamide quinolin* toluenesulfonate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 9,133,162 B2 (Xi) 15 September 2015 (15.09.2015) entire document especially table 1, compound of formula I	1-8
A	US 8,232,294 B2 (Xi) 31 July 2012 (31.07.2012) entire document especially col 3-4 and table 1 compounds	1-8
A	US 8,088,794 B2 (Kim et al.) 03 January 2012 (03.01.2012) entire document	1-8
A	US 7,858,623 B2 (Kim et al.) 28 December 2010 (28.12.2010) entire document	1-8
A	US 2014/243339 A1 (Burgess et al.) 28 August 2014 (28.08.2014) entire document	1-8

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
 23 December 2016

Date of mailing of the international search report

09 JAN 2017

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 Lee W. Young
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 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/61717

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: 9-17 because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.