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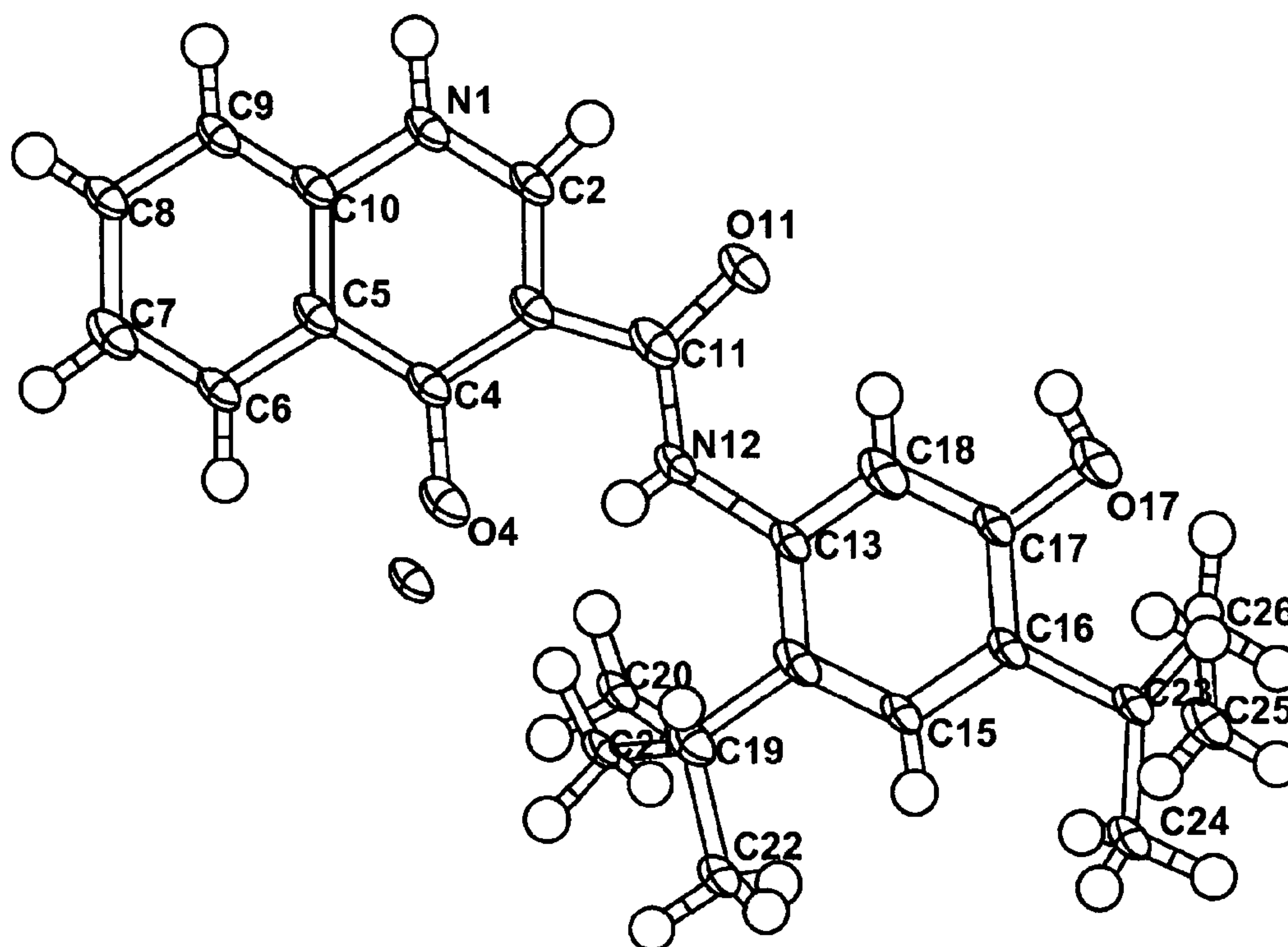
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(72) Inventeurs/Inventors:
HURTER, PATRICIA, US;
YOUNG, CHRISTOPHER R., US;
COSTACHE, ADRIANA, US;
CONNELLY, PATRICK, US;
KRAWIEC, MARIUSZ, US;
GONG, YUCHUAN, US;
...

(73) Propriétaire/Owner:
VERTEX PHARMACEUTICALS INCORPORATED, US

(74) Agent: SMART & BIGGAR

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(57) Abrégé/Abstract:

The present invention relates to solid state forms of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide (Compound 1), pharmaceutical compositions thereof and methods therewith.



(72) Inventeurs(suite)/Inventors(continued): ROWE, WILLIAM, ZZ; FENG, YUSHI, US; TRUDEAU, MARTIN, CA

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ABSTRACT

The present invention relates to solid state forms of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide (Compound 1), and pharmaceutical compositions thereof.

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5 SOLID FORMS OF N-[2,4-BIS(1,1-DIMETHYLETHYL)-5-HYDROXYPHENYL]-1,4-
DIHYDRO-4-OXOQUINOLINE-3-CARBOXAMIDE

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TECHNICAL FIELD OF THE INVENTION

[001] The present invention relates to solid state forms, for example, crystalline and amorphous forms, of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-
15 oxoquinoline-3-carboxamide, and pharmaceutical compositions thereof.

BACKGROUND OF THE INVENTION

[002] CFTR is a cAMP/ATP-mediated anion channel that is expressed in a variety of cells types, including absorptive and secretory epithelia cells, where it regulates anion flux across
20 the membrane, as well as the activity of other ion channels and proteins. In epithelia cells, normal functioning of CFTR is critical for the maintenance of electrolyte transport throughout the body, including respiratory and digestive tissue. CFTR is composed of approximately 1480 amino acids that encode a protein made up of a tandem repeat of transmembrane domains, each containing six transmembrane helices and a nucleotide binding domain. The two transmembrane
25 domains are linked by a large, polar, regulatory (R)-domain with multiple phosphorylation sites that regulate channel activity and cellular trafficking.

[003] The gene encoding CFTR has been identified and sequenced (See Gregory, R. J. et al. (1990) Nature 347:382-386; Rich, D. P. et al. (1990) Nature 347:358-362), (Riordan, J. R. et al. (1989) Science 245:1066-1073). A defect in this gene causes mutations in CFTR resulting
30 in cystic fibrosis ("CF"), the most common fatal genetic disease in humans. Cystic fibrosis affects approximately one in every 2,500 infants in the United States. Within the general United States population, up to 10 million people carry a single copy of the defective gene without

5 apparent ill effects. In contrast, individuals with two copies of the CF associated gene suffer from the debilitating and fatal effects of CF, including chronic lung disease.

10 [004] In patients with cystic fibrosis, mutations in CFTR endogenously expressed in respiratory epithelia leads to reduced apical anion secretion causing an imbalance in ion and fluid transport. The resulting decrease in anion transport contributes to enhanced mucus accumulation in the lung and the accompanying microbial infections that ultimately cause death in CF patients. In addition to respiratory disease, CF patients typically suffer from gastrointestinal problems and pancreatic insufficiency that, if left untreated, results in death. In addition, the majority of males with cystic fibrosis are infertile and fertility is decreased among females with cystic fibrosis. In contrast to the severe effects of two copies of the CF associated gene, individuals with a single
15 copy of the CF associated gene exhibit increased resistance to cholera and to dehydration resulting from diarrhea – perhaps explaining the relatively high frequency of the CF gene within the population.

20 [005] Sequence analysis of the CFTR gene of CF chromosomes has revealed a variety of disease causing mutations (Cutting, G. R. et al. (1990) Nature 346:366-369; Dean, M. et al. (1990) Cell 61:863:870; and Kerem, B-S. et al. (1989) Science 245:1073-1080; Kerem, B-S et al. (1990) Proc. Natl. Acad. Sci. USA 87:8447-8451). To date, > 1000 disease causing mutations in the CF gene have been identified (<http://www.genet.sickkids.on.ca/cftr/>). The most prevalent mutation is a deletion of phenylalanine at position 508 of the CFTR amino acid sequence, and is commonly referred to as $\Delta F508$ -CFTR. This mutation occurs in approximately
25 70% of the cases of cystic fibrosis and is associated with a severe disease .

30 [006] The deletion of residue 508 in $\Delta F508$ -CFTR prevents the nascent protein from folding correctly. This results in the inability of the mutant protein to exit the ER, and traffic to the plasma membrane. As a result, the number of channels present in the membrane is far less than observed in cells expressing wild-type CFTR. In addition to impaired trafficking, the mutation results in defective channel gating. Together, the reduced number of channels in the membrane and the defective gating lead to reduced anion transport across epithelia leading to defective ion and fluid transport. (Quinton, P. M. (1990), FASEB J. 4: 2709-2727). Studies have shown, however, that the reduced numbers of $\Delta F508$ -CFTR in the membrane are functional, albeit less than wild-type CFTR. (Dalemans et al. (1991), Nature Lond. 354: 526-528; Denning
35 et al., supra; Pasyk and Foskett (1995), J. Cell. Biochem. 270: 12347-50). In addition to $\Delta F508$ -

5 CFTR, other disease causing mutations in CFTR that result in defective trafficking, synthesis, and/or channel gating could be up- or down-regulated to alter anion secretion and modify disease progression and/or severity.

[007] Although CFTR transports a variety of molecules in addition to anions, it is clear that this role (the transport of anions) represents one element in an important mechanism of transporting ions and water across the epithelium. The other elements include the epithelial Na⁺
10 channel, ENaC, Na⁺/2Cl⁻/K⁺ co-transporter, Na⁺-K⁺-ATPase pump and the basolateral membrane K⁺ channels, that are responsible for the uptake of chloride into the cell.

[008] These elements work together to achieve directional transport across the epithelium via their selective expression and localization within the cell. Chloride absorption
15 takes place by the coordinated activity of ENaC and CFTR present on the apical membrane and the Na⁺-K⁺-ATPase pump and Cl⁻ channels expressed on the basolateral surface of the cell. Secondary active transport of chloride from the luminal side leads to the accumulation of intracellular chloride, which can then passively leave the cell via Cl⁻ channels, resulting in a vectorial transport. Arrangement of Na⁺/2Cl⁻/K⁺ co-transporter, Na⁺-K⁺-ATPase pump and the
20 basolateral membrane K⁺ channels on the basolateral surface and CFTR on the luminal side coordinate the secretion of chloride via CFTR on the luminal side. Because water is probably never actively transported itself, its flow across epithelia depends on tiny transepithelial osmotic gradients generated by the bulk flow of sodium and chloride.

[009] In addition to cystic fibrosis, modulation of CFTR activity may be beneficial
25 for other diseases not directly caused by mutations in CFTR, such as secretory diseases and other protein folding diseases mediated by CFTR. These include, but are not limited to, chronic obstructive pulmonary disease (COPD), dry eye disease, and Sjögren's Syndrome. COPD is characterized by airflow limitation that is progressive and not fully reversible. The airflow limitation is due to mucus hypersecretion, emphysema, and bronchiolitis. Activators of mutant
30 or wild-type CFTR offer a potential treatment of mucus hypersecretion and impaired mucociliary clearance that is common in COPD. Specifically, increasing anion secretion across CFTR may facilitate fluid transport into the airway surface liquid to hydrate the mucus and optimized periciliary fluid viscosity. This would lead to enhanced mucociliary clearance and a reduction in the symptoms associated with COPD. Dry eye disease is characterized by a decrease in tear
35 aqueous production and abnormal tear film lipid, protein and mucin profiles. There are many

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5 causes of dry eye, some of which include age, Lasik eye surgery, arthritis, medications,
chemical/thermal burns, allergies, and diseases, such as cystic fibrosis and Sjögren's syndrome.
Increasing anion secretion via CFTR would enhance fluid transport from the corneal endothelial
cells and secretory glands surrounding the eye to increase corneal hydration. This would help to
alleviate the symptoms associated with dry eye disease. Sjögren's syndrome is an autoimmune
10 disease in which the immune system attacks moisture-producing glands throughout the body,
including the eye, mouth, skin, respiratory tissue, liver, vagina, and gut. Symptoms, include, dry
eye, mouth, and vagina, as well as lung disease. The disease is also associated with rheumatoid
arthritis, systemic lupus, systemic sclerosis, and polymyositis/dermatomyositis. Defective
protein trafficking is believed to cause the disease, for which treatment options are limited.
15 Modulators of CFTR activity may hydrate the various organs afflicted by the disease and help to
alleviate the associated symptoms.

[010] As discussed above, it is believed that the deletion of residue 508 in $\Delta F508$ -
CFTR prevents the nascent protein from folding correctly, resulting in the inability of this mutant
protein to exit the ER, and traffic to the plasma membrane. As a result, insufficient amounts of
20 the mature protein are present at the plasma membrane and chloride transport within epithelial
tissues is significantly reduced. In fact, this cellular phenomenon of defective ER processing of
ABC transporters by the ER machinery, has been shown to be the underlying basis not only for
CF disease, but for a wide range of other isolated and inherited diseases. The two ways that the
ER machinery can malfunction is either by loss of coupling to ER export of the proteins leading
25 to degradation, or by the ER accumulation of these defective/misfolded proteins [Aridor M, *et al.*,
Nature Med., 5(7), pp 745- 751 (1999); Shastry, B.S., *et al.*, *Neurochem. International*, 43,
pp 1-7 (2003); Rutishauser, J., *et al.*, *Swiss Med Wkly*, 132, pp 211-222 (2002); Morello, JP *et al.*,
TIPS, 21, pp. 466- 469 (2000); Bross P., *et al.*, *Human Mut.*, 14, pp. 186-198 (1999)]. The
diseases associated with the first class of ER malfunction are cystic fibrosis (due to misfolded
30 $\Delta F508$ -CFTR as discussed above), hereditary emphysema (due to $\alpha 1$ -antitrypsin; non Piz
variants), hereditary hemochromatosis, hoagulation-fibrinolysis deficiencies, such as protein C
deficiency, Type 1 hereditary angioedema, lipid processing deficiencies, such as familial
hypercholesterolemia, Type 1 chylomicronemia, abetalipoproteinemia, lysosomal storage
diseases, such as I-cell disease/pseudo-Hurler, Mucopolysaccharidoses (due to lysosomal
35 processing enzymes), Sandhof/Tay-Sachs (due to β -hexosaminidase), Crigler-Najjar type II (due

5 to UDP-glucuronyl-sialyl-transferase), polyendocrinopathy/hyperinsulemia, Diabetes mellitus (due to insulin receptor), Laron dwarfism (due to growth hormone receptor), myeloperoxidase deficiency, primary hypoparathyroidism (due to preproparathyroid hormone), melanoma (due to tyrosinase). The diseases associated with the latter class of ER malfunction are Glycanosis CDG type 1, hereditary emphysema (due to α 1-Antitrypsin (PiZ variant), congenital hyperthyroidism, 10 osteogenesis imperfecta (due to Type I, II, IV procollagen), hereditary hypofibrinogenemia (due to fibrinogen), ACT deficiency (due to α 1-antichymotrypsin), Diabetes insipidus (DI), neurophyseal DI (due to vasopressin hormone/V2-receptor), neprogenic DI (due to aquaporin II), Charcot-Marie Tooth syndrome (due to peripheral myelin protein 22), Perlizaeus-Merzbacher disease, neurodegenerative diseases such as Alzheimer's disease (due to β APP and presenilins), 15 Parkinson's disease, amyotrophic lateral sclerosis, progressive supranuclear palsy, Pick's disease, several polyglutamine neurological disorders asuch as Huntington, spinocerebellar ataxia type I, spinal and bulbar muscular atrophy, dentatorubal pallidoluyian, and myotonic dystrophy, as well as spongiform encephalopathies, such as hereditary Creutzfeldt-Jakob disease (due to prion protein processing defect), Fabry disease (due to lysosomal α -galactosidase A) and 20 Straussler-Scheinker syndrome (due to Prp processing defect).

[011] In addition to up-regulation of CFTR activity, reducing anion secretion by CFTR modulators may be beneficial for the treatment of secretory diarrheas, in which epithelial water transport is dramatically increased as a result of secretagogue activated chloride transport. The mechanism involves elevation of cAMP and stimulation of CFTR.

25 [012] Although there are numerous causes of diarrhea, the major consequences of diarrheal diseases, resulting from excessive chloride transport are common to all, and include dehydration, acidosis, impaired growth and death.

[013] Acute and chronic diarrheas represent a major medical problem in many areas of the world. Diarrhea is both a significant factor in malnutrition and the leading cause of death 30 (5,000,000 deaths/year) in children less than five years old.

[014] Secretory diarrheas are also a dangerous condition in patients of acquired immunodeficiency syndrome (AIDS) and chronic inflammatory bowel disease (IBD). 16 million travelers to developing countries from industrialized nations every year develop diarrhea, with the severity and number of cases of diarrhea varying depending on the country and area of travel.

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5 [015] Diarrhea in barn animals and pets such as cows, pigs and horses, sheep, goats, cats and dogs, also known as scours, is a major cause of death in these animals. Diarrhea can result from any major transition, such as weaning or physical movement, as well as in response to a variety of bacterial or viral infections and generally occurs within the first few hours of the animal's life.

10 [016] The most common diarrheal causing bacteria is enterotoxogenic E.coli (ETEC) having the K99 pilus antigen. Common viral causes of diarrhea include rotavirus and coronavirus. Other infectious agents include cryptosporidium, giardia lamblia, and salmonella, among others.

15 [017] Symptoms of rotaviral infection include excretion of watery feces, dehydration and weakness. Coronavirus causes a more severe illness in the newborn animals, and has a higher mortality rate than rotaviral infection. Often, however, a young animal may be infected with more than one virus or with a combination of viral and bacterial microorganisms at one time. This dramatically increases the severity of the disease.

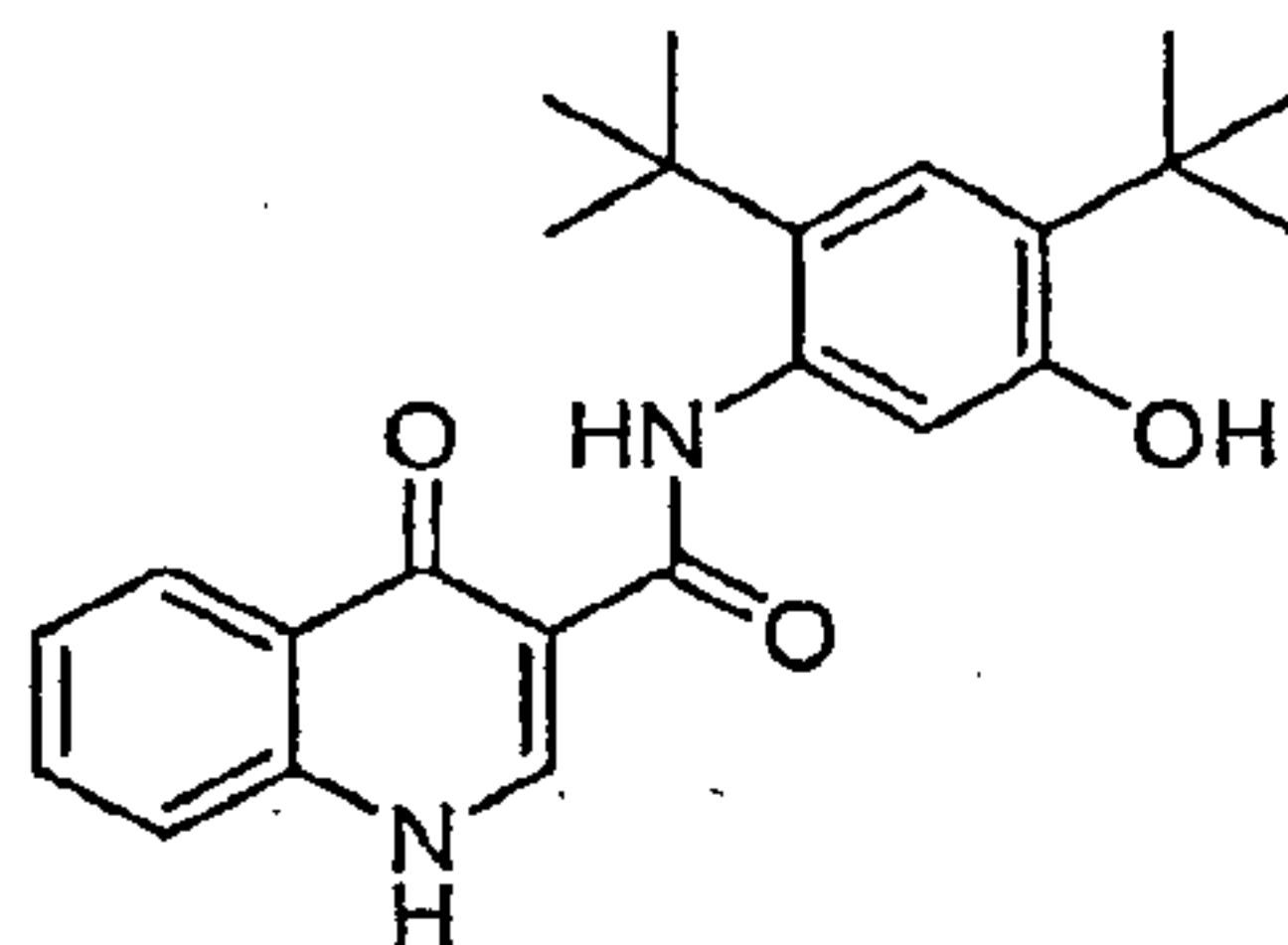
20 [018] Accordingly, there is a need for stable polymorphic forms of modulators of CFTR activity, such as Compound 1, that can be used to modulate the activity of CFTR in the cell membrane of a mammal.

 [019] Compound 1 is disclosed in PCT/US2005/022768, as well as its role in modulating CFTR activity.

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SUMMARY OF THE INVENTION

[020] The present invention relates to solid forms of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide (hereinafter "Compound 1") which has the structure below:



30

Compound 1

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[021] In one aspect, the invention features a solid dispersion comprising amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide. In another aspect, the solid dispersion further comprises a polymer. In another aspect, the solid dispersion further comprises a surfactant, polymer, or inert pharmaceutically acceptable substance.

[022] In some embodiments, the solid dispersion comprises less than about 40% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide. In some embodiments, the solid dispersion is substantially free of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

[023] In some embodiments, the solid dispersion comprises a polymer, and the polymer is one or more than one water-soluble polymer or partially water-soluble polymer.

[024] In some embodiments, the polymer is hydroxypropylmethylcellulose (HPMC), hydroxypropylcellulose (HPC), ethylcellulose, hydroxypropylmethylcellulose acetate succinate (HPMCAS), polyvinylpyrrolidones (PVP), polyethylene glycols (PEG), polyvinyl alcohols (PVA), polymethacrylate, β -cyclodextrin, or vinylpyrrolidone/vinyl acetate copolymer (PVP/VA).

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[025] In some embodiments, the polymer is hydroxypropylmethylcellulose (HPMC). In some embodiments, the polymer is hydroxypropylmethylcellulose acetate succinate (HPMCAS). In some embodiments, the polymer is vinylpyrrolidone/vinyl acetate copolymer (PVP/VA). In some embodiments, the polymer is present in an amount of from
5 about 10% by weight to about 80% by weight, for example, the polymer is present in an amount of less than about 70% by weight, the polymer is present in an amount of about 50% by weight, or the polymer is present in an amount of about 49.5% by weight.

[026] In some embodiments, the N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an amount of from
10 about 10% by weight to about 80% by weight, for example, the N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an amount of less than about 70% by weight or the N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an amount of about 50% by weight.

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[027] In some embodiments, the solid dispersion comprises a surfactant, for example, sodium lauryl sulfate. In some embodiments, the surfactant is present in an amount from about 0.1 to about 5%, for example, the surfactant is present in 0.5%.

[028] In some embodiments, at least about 80% by weight of the N N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is in an amorphous form. In some embodiments, substantially all the N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is in an amorphous form.

[029] In some embodiments, the solid dispersion is obtained by spray drying.

[030] In one aspect, the invention features, a pharmaceutical composition comprising an amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide as a solid dispersion and a pharmaceutically acceptable carrier, adjuvant or vehicle.

[031] In some embodiments, the solid dispersion comprises a polymer and wherein the polymer is one or more than one water-soluble polymer or partially water-soluble polymer.

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[032] In some embodiments, the polymer is hydroxypropylmethylcellulose (HPMC), hydroxypropylcellulose (HPC), ethylcellulose, hydroxypropylmethylcellulose acetate succinate (HPMCAS), polyvinylpyrrolidones (PVP), polyethylene glycols (PEG), polyvinyl alcohols (PVA), polymethacrylate, β -cyclodextrin, or vinylpyrrolidone/vinyl acetate copolymer (PVP/VA).

[033] In some embodiments, the polymer is HPMC. In some embodiments, the polymer is HPMCAS. In some embodiments, the polymer is PVP/VA.

[034] In one aspect, the invention features a pharmaceutical composition comprising: an amorphous solid dispersion of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide wherein said N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide comprises about 30-75% wt/wt of the pharmaceutical composition, one or more polymer selected from the group of HPMC and HPMCAS, wherein said polymer is comprises about 30-75% wt/wt of the pharmaceutical composition, a surfactant, wherein said surfactant comprises about 0.25-1% wt/wt of the pharmaceutical composition, and a pharmaceutically acceptable carrier, adjuvant or vehicle.

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[035] In some embodiments, the polymer is HPMCAS. In some embodiments, the polymer is HPMC.

[036] In some embodiments, the surfactant is sodium laurel sulfate.

[037] In some embodiments, said N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide comprises about 50% wt/wt of the pharmaceutical composition, said polymer is HPMCAS and comprises about 49.5% wt/wt of the pharmaceutical composition, and a said surfactant is sodium laurel sulfate and comprises about 0.5% wt/wt of the pharmaceutical composition.

[038] In one aspect, the invention features a process for preparing an amorphous form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide comprising spray-drying N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide to provide an amorphous form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

[039] In some embodiments, the process comprises combining N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and a suitable solvent to form a mixture and then spray-drying the mixture to obtain the amorphous form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

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[040] In some embodiments, the mixture is a solution N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and the suitable solvent. In some embodiments, the suitable solvent comprises acetone or MEK. In some embodiments, the suitable solvent comprises a mixture of solvents, for example, a mixture of acetone and water or a mixture of MEK and water. In some embodiments, the water in the solvent mixture is present at about 10% wt.

[041] In some embodiments, the process comprises a) forming a mixture comprising N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, a polymer, and a solvent; and b) spray-drying the mixture to form a solid dispersion comprising N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

[042] In some embodiments, the mixture comprises a solution of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, the polymer, and the solvent. In some embodiments, the polymer is selected from HPMC and HPMCAS. In some embodiments, the polymer is PVP/VA. In some embodiments, the polymer is present in an amount of from about 30% to about 70% by weight in the solid dispersion. In some embodiments, the mixture further comprises a surfactant, for example, SLS.

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[043] In some embodiments, the solvent comprises acetone, for example, a mixture of acetone and water. In some embodiments, the solvent comprises from about 0% to about 20% by weight water. In some embodiments, the solvent comprises from about 70% to about 100% by weight acetone.

5 [044] In one aspect, the invention features a solid dispersion prepared according to a process described herein.

[045] In one aspect, the invention features a crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, characterized by a peak at 5.0 degrees, and 15.6 degrees in an X-ray powder diffraction pattern obtained
10 using Cu K alpha radiation. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 9.9 degrees. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a following peak at 14.9 degrees. In some embodiments, the crystal
15 form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 18.1 degrees. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 28.0 degrees. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-
20 3-carboxamide is further characterized by a peak at 30.9 degrees. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is characterized by an X-ray powder diffraction pattern obtained using Cu K alpha radiation substantially similar to **FIGURE 4**.

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[046] In one aspect, the invention features a pharmaceutical composition comprising the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide having the characteristics of Form A, for example as described above, and a pharmaceutically acceptable adjuvant or carrier.

5 [047] In one aspect, the invention features a process for preparing a crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide of Form A, for example as characterized above, wherein said process comprises the step of heating N N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide to about 250°C and cooling to room temperature.

10 [048] In one aspect, the invention features solid amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

[049] In one aspect, the invention features a composition comprising solid amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and less than 15% crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-
15 1,4-dihydro-4-oxoquinoline-3-carboxamide.

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[050] In one aspect, the invention features a pharmaceutical composition comprising solid amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and a pharmaceutically acceptable carrier, adjuvant or vehicle.

5 [051] In one aspect, the invention features a crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, characterized by one or more peaks at 6.2, 7.6, 12.3 and 18.0 degrees in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.

[052] In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a
10 peak at 8.4 degrees. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 14.8 degrees. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 21.1 degrees. In some embodiments, the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is
15 characterized by an X-ray powder diffraction pattern obtained using Cu K alpha radiation substantially similar to **FIGURE 7**.

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[053] In one aspect, the invention features a pharmaceutical composition comprising the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide according to Form B, for example, as characterized above, and a pharmaceutically acceptable adjuvant or carrier.

5 [054] In one aspect, the invention features a process for preparing the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide according to Form B, for example, as characterized above, wherein said process comprises the steps of alternatively heating and cooling a slurry of Compound 1 and acetonitrile. In some embodiments, the process comprises heating said slurry at about 50°C
10 for about 12 hours. In some embodiments, said cooling step comprises placing said slurry at room temperature for about 12 hours, followed by cooling at about 0°C overnight.

[055] In one aspect, the invention features a crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, having a monoclinic crystal system, a P21 space grouping, and the following unit cell dimensions:

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$$[056] \ a = 11.8011(7) \text{ \AA} \quad \alpha = 90^\circ$$

$$[057] \ b = 5.9819(3) \text{ \AA} \quad \beta = 105.110(4)^\circ$$

$$[058] \ c = 14.7974(8) \text{ \AA} \quad \gamma = 90^\circ.$$

[059] - [076]

5 [077] Processes described herein can be used to prepare the compositions of this invention. The amounts and the features of the components used in the processes would be as described herein.

[078] As used herein, the term "amorphous" refers to a solid material having no long range order in the position of its molecules. Amorphous solids are generally
10 supercooled liquids in which the molecules are arranged in a random manner so that there is no well-defined arrangement, e.g., molecular packing, and no long range order. Amorphous solids are generally isotropic, i.e. exhibit similar properties in all directions and do not have definite melting points. For example, an amorphous material is a solid material having no sharp characteristic crystalline peak(s) in its X-ray power diffraction (XRPD) pattern (i.e., is
15 not crystalline as determined by XRPD). Instead, one or several broad peaks (e.g., halos) appear in

5 its XRPD pattern. Broad peaks are characteristic of an amorphous solid. See, US 2004/0006237 for a comparison of XRPDs of an amorphous material and crystalline material.

[079] As used herein, the phrase "substantially amorphous Compound 1" is used interchangeably with the phrase "amorphous Compound 1 substantially free of crystalline Compound 1." In some embodiments, substantially amorphous Compound 1 has less than
10 about 30% crystalline Compound 1, for example, less than about 30% of crystalline Compound 1, e.g., less than about 25% crystalline Compound 1, less than about 20% crystalline Compound 1, less than about 15% crystalline Compound 1, less than about 10% crystalline Compound 1, less than about 5% crystalline Compound 1, less than about 2% crystalline Compound 1. In some preferred embodiments, Compound 1 has less than about 15%
15 crystalline compound 1. Some embodiments include a preparation of substantially amorphous Compound 1, for example having the degree of crystalline Compound 1 as described above.

[080] As used herein "crystalline solids" refers to compounds or compositions where the structural units are arranged in fixed geometric patterns or lattices, so that crystalline solids have rigid long range order. The structural units that constitute the crystal structure can be
20 atoms, molecules, or ions. Crystalline solids show definite melting points.

[081] As used herein, a "dispersion" refers to a disperse system in which one substance, the dispersed phase, is distributed, in discrete units, throughout a second substance (the continuous phase or vehicle). The size of the dispersed phase can vary considerably (e.g. colloidal particles of nanometer dimension, to multiple microns in size). In general, the
25 dispersed phases can be solids, liquids, or gases. In the case of a solid dispersion, the dispersed and continuous phases are both solids. In pharmaceutical applications, a solid dispersion can include a crystalline drug (dispersed phase) in an amorphous polymer (continuous phase), or alternatively, an amorphous drug (dispersed phase) in an amorphous polymer (continuous phase). In some embodiments an amorphous solid dispersion includes the polymer constituting
30 the dispersed phase, and the drug constitute the continuous phase. In some embodiments, the dispersion includes amorphous Compound 1 or substantially amorphous Compound 1.

[082] The term "solid amorphous dispersion" generally refers to a solid dispersion of two or more components, usually a drug and polymer, but possibly containing other components such as surfactants or other pharmaceutical excipients, where Compound 1 is
35 amorphous or substantially amorphous (e.g., substantially free of crystalline Compound 1), and

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the physical stability and/or dissolution and/or solubility of the amorphous drug is enhanced by the other components.

[083] A solid dispersion as provided herein is a particularly favorable embodiment of this invention. Solid dispersions typically include a compound dispersed in an appropriate carrier medium, such as a solid state carrier. In one embodiment, a carrier according to this invention comprises a polymer, preferably, a water-soluble polymer or a partially water-soluble polymer. It would be understood that one or more than one water-soluble polymer could be used in a solid dispersion of this invention.

[084] An exemplary solid dispersion is a co-precipitate or a co-melt of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide with at least one polymer. A "Co-precipitate" is a product after dissolving a drug and a polymer in a solvent or solvent mixture followed by the removal of the solvent or solvent mixture. Sometimes the polymer can be suspended in the solvent or solvent mixture. The solvent or solvent mixture includes organic solvents and supercritical fluids. A "co-melt" is a product after heating a drug and a polymer to melt, optionally in the presence of a solvent or solvent mixture, followed by mixing, removal of at least a portion of the solvent if applicable, and cooling to room temperature at a selected rate. In some cases, the solid dispersions are prepared by adding a solution of a drug and a solid polymer followed by mixing and removal of the solvent. To remove the solvent, vacuum drying, spray drying, tray drying, lyophilization, and other drying procedures may be applied. Applying any of these methods using appropriate processing parameters, according to this invention, would provide N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide in an amorphous state in the final solid dispersion product.

[085] BRIEF DESCRIPTION OF THE DRAWINGS

[086] FIGURE 1 is an X-Ray powder diffraction pattern of Compound 1.

[087] FIGURE 2 is the ¹H NMR spectrum of Compound 1.

[088] FIGURE 3 is the DSC trace of Compound 1.

[089] FIGURE 4 is the X-Ray powder diffraction pattern of Form A.

[090] FIGURE 5 is the DSC trace of Form A.

[091] FIGURE 6 is the TGA trace of Form A.

[096] **FIGURE 11** is the X-Ray powder diffraction pattern of the Amorphous Form.

[097] **FIGURE 12** is the TGA trace of the Amorphous Form.

[098] **FIGURE 13** is the DSC trace of the Amorphous Form.

[0101] Form A

example, about 29.4, e.g., 29.35; and about from about 30.7 to about 31.1, for example, 30.9,

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5 e.g., 30.85. For example, Form A can be characterized by an X-ray powder diffraction pattern obtained using Cu K alpha radiation substantially similar to **FIGURE 4**.

[0103] Pharmaceutical compositions including Form A and a pharmaceutically acceptable adjuvant or carrier, such as a polymer or surfactant are also described. Form A can be formulated in a pharmaceutical composition.

10

[0104] Processes for preparing Form A are exemplified herein.

[0105]

15

[0106] Form B

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[0107] The solid state crystal Form B of Compound 1 is characterized by one or more peaks at from about 6.0 to about 6.4 for example, about 6.2, e.g., 6.17, from about 7.4 to about 7.8 for example, about 7.6, e.g., 7.61, from about 12.1 to about 12.5 for example, about 12.3, e.g., 12.33, and from about 17.8 to about 18.2 for example, about 18.0, e.g., 17.96 degrees in an X-ray powder diffraction pattern obtained using Cu K alpha radiation (2θ). Other peaks (2θ), which can be characteristic of Form B, include the following: from about 8.2 to about 8.6 for example, about 8.4, e.g., 8.40; from about 10.8 to about 11.2 for example, about 11.0, e.g., 11.02; from about 14.6 to about 15.0 for example, about 14.8, e.g., 14.83; from about 15.9 to about 16.3 for example, about 16.1, e.g., 16.14; from about 16.9 to about 17.3 for example, about 17.1, e.g., 17.11; from about 18.4 to about 18.8 for example, about 18.6, e.g., 18.55; from about 19.2 to about 19.6 for example, about 19.4, e.g., 19.43; from about 20.9 to about 21.3 for example, about 21.1, e.g., 21.05; from about 22.4 to about 22.8 for example, about 22.6, e.g., 22.56; from about 23.2 to about 23.6 for example, about 23.4, e.g., 23.37; from about 23.7 to about 24.1 for example, about 23.9, e.g., 23.94; from about 24.7 to about 25.1 for example, about 24.9, e.g., 24.86; from about 25.3 to about 25.7 for example, about 25.5, e.g., 25.50; from about 26.5 to about 26.9 for example, about 26.7, e.g., 26.72; from about 27.3 to about 27.7 for example, about 27.5, e.g., 27.51; from about 29.4 to about 29.8 for example, about 29.6, e.g., 29.60; from about 33.3 to about 33.7 for example, about 33.5, e.g., 33.48; and from about 36.6 to about 37.0 for example, about 36.8, e.g., 36.78. Form B can be further

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5 characterized, for example, by an X-ray powder diffraction pattern obtained using Cu K alpha radiation substantially similar to **FIGURE 7**.

[0108] Applicants have determined crystal structure dimensions of Form B by analysis of single crystal data. Form B is a monoclinic crystal system having a $P2_1$ space grouping, and the following unit cell dimensions: $a = 11.8011(7) \text{ \AA}$, $\alpha = 90^\circ$; $b = 5.9819(3) \text{ \AA}$, $\beta =$
10 $105.110(4)^\circ$; $c = 14.7974(8) \text{ \AA}$, $\gamma = 90^\circ$. Additional details about the structure and packing of Form B are provided in the Examples.

[0109] Pharmaceutical compositions including Form B and a pharmaceutically acceptable adjuvant or carrier, such as a polymer or surfactant are also described. Form B can be formulated in a pharmaceutical composition.

15

[0110] Processes for preparing Form B are exemplified herein.

[0111]

20

[0112] Amorphous Compound 1

[0113] Compound 1 can be present as an amorphous solid, for example amorphous Compound 1 as a substantially neat preparation, or amorphous compound 1 as a component as a dispersion such as a solid amorphous dispersion.

[0114] In some embodiments, an amorphous form of Compound 1 is substantially free
25 of crystalline Compound 1 (e.g., Form A, Form B or any crystalline form of Compound 1), for example Compound 1 has less than about 30% of crystalline Compound 1, e.g., less than about 25% crystalline Compound 1, less than about 20% crystalline Compound 1, less than about 15% crystalline Compound 1, less than about 10% crystalline Compound 1, less than about 5% crystalline Compound 1, less than about 2% crystalline. Compound 1, preferably less than
30 about 15% crystalline compound 1. Compound 1 can be characterized by an X-ray powder diffraction pattern obtained using Cu K alpha radiation substantially similar to **FIGURE 11**. For example, the substantially amorphous form of Compound 1 can be characterized as having an XRPD having no sharp characteristic crystalline peak(s) in its X-ray power diffraction (XRPD) pattern (i.e., is not crystalline as determined by XRPD). Instead, one or several broad
35 peaks (e.g., halos) appear in its XRPD pattern.

5 **[0115] Polymers**

[0116] Solid dispersions including amorphous Compound 1 and a polymer (or solid state carrier) also are included herein. For example, Compound 1 is present as an amorphous compound as a component of a solid amorphous dispersion. The solid amorphous dispersion, generally includes Compound 1 and a polymer. Exemplary polymers include cellulosic
10 polymers such as HPMC or HPMCAS and pyrrolidone containing polymers such as PVP/VA. In some embodiments, the solid amorphous dispersion includes one or more additional excipients, such as a surfactant.

[0117] In one embodiment, a polymer is able to dissolve in aqueous media. The solubility of the polymers may be pH-independent or pH-dependent. The latter include one or
15 more enteric polymers. The term "enteric polymer" refers to a polymer that is preferentially soluble in the less acidic environment of the intestine relative to the more acid environment of the stomach, for example, a polymer that is insoluble in acidic aqueous media but soluble when the pH is above 5-6. An appropriate polymer should be chemically and biologically inert. In order to improve the physical stability of the solid dispersions, the glass transition temperature
20 (T_g) of the polymer should be as high as possible. For example, preferred polymers have a glass transition temperature at least equal to or greater than the glass transition temperature of the drug (e.g., Compound 1). Other preferred polymers have a glass transition temperature that is within about 10 to about 15 °C of the drug (e.g., Compound 1). Examples of suitable glass transition temperatures of the polymers include at least about 90 °C, at least about 95 °C, at
25 least about 100 °C, at least about 105 °C, at least about 110 °C, at least about 115 °C, at least about 120 °C, at least about 125 °C, at least about 130 °C, at least about 135 °C, at least about 140 °C, at least about 145 °C, at least about 150 °C, at least about 155 °C, at least about 160 °C, at least about 165 °C, at least about 170 °C, or at least about 175 °C (as measured under dry conditions). Without wishing to be bound by theory, it is believed that the underlying
30 mechanism is that a polymer with a higher T_g generally has lower molecular mobility at room temperature, which can be a crucial factor in stabilizing the physical stability of the amorphous solid dispersion.

[0118] Additionally, the hygroscopicity of the polymers should be as low, e.g., less than about 10%. For the purpose of comparison in this application, the hygroscopicity of a
35 polymer or composition is characterized at about 60% relative humidity. In some preferred

embodiments, the polymer has less than about 10% water absorption, for example less than about 9%, less than about 8%, less than about 7%, less than about 6%, less than about 5%, less than about 4%, less than about 3%, or less than about 2% water absorption. The hygroscopicity can also affect the physical stability of the solid dispersions. Generally, moisture adsorbed in the polymers can greatly reduce the T_g of the polymers as well as the resulting solid dispersions, which will further reduce the physical stability of the solid dispersions as described above.

[0119] In one embodiment, the polymer is one or more water-soluble polymer(s) or partially water-soluble polymer(s). Water-soluble or partially water-soluble polymers include but are not limited to, cellulose derivatives (e.g., hydroxypropylmethylcellulose (HPMC), hydroxypropylcellulose (HPC)) or ethylcellulose; polyvinylpyrrolidones (PVP); polyethylene glycols (PEG); polyvinyl alcohols (PVA); acrylates, such as polymethacrylate (e.g., Eudragit® E); cyclodextrins (e.g., β -cyclodextrin) and copolymers and derivatives thereof, including for example PVP-VA (polyvinylpyrrolidone-vinyl acetate).

[0120] In some preferred embodiments, the polymer is hydroxypropylmethylcellulose (HPMC), such as HPMC E50, HPMCE15, or HPMC60SH50).

[0121] As discussed herein, the polymer can be a pH-dependent enteric polymer. Such pH-dependent enteric polymers include, but are not limited to, cellulose derivatives (e.g., cellulose acetate phthalate (CAP)), hydroxypropyl methyl cellulose phthalates (HPMCP), hydroxypropyl methyl cellulose acetate succinate (HPMCAS), carboxymethylcellulose (CMC) or a salt thereof (e.g., a sodium salt such as (CMC-Na)); cellulose acetate trimellitate (CAT), hydroxypropylcellulose acetate phthalate (HPCAP), hydroxypropylmethyl-cellulose acetate phthalate (HPMCAP), and methylcellulose acetate phthalate (MCAP), or polymethacrylates (e.g., Eudragit® S). In some preferred embodiments, the polymer is hydroxypropyl methyl cellulose acetate succinate (HPMCAS).

[0122] In yet another embodiment, the polymer is a polyvinylpyrrolidone co-polymer, for example, avinylpyrrolidone/vinyl acetate co-polymer (PVP/VA).

[0123] In embodiments where Compound 1 forms a solid dispersion with a polymer, for example with an HPMC, HPMCAS or PVP/VA polymer, the amount of polymer relative to the total weight of the solid dispersion ranges from about 0.1% to 99% by weight. Unless otherwise specified, percentages of drug, polymer and other excipients as described within a

5 dispersion are given in weight percentages. The amount of polymer is typically at least about 20%, and preferably at least about 30%, for example, at least about 35%, at least about 40%, at least about 45%, or about 50% (e.g., 49.5%). The amount is typically about 99% or less, and preferably about 80% or less, for example about 75% or less, about 70% or less, about 65% or less, about 60% or less, or about 55% or less. In one embodiment, the polymer is in an amount
10 of up to about 50% of the total weight of the dispersion (and even more specifically, between about 40% and 50%, such as about 49%, about 49.5%, or about 50%). HPMC and HPMCAS are available in a variety of grades from ShinEtsu, for example, HPMCAS is available in a number of varieties, including AS-LF, AS-MF, AS-HF, AS-LG, AS-MG, AS-HG. Each of these grades vary with the percent substitution of acetate and succinate.

15 [0124] In some preferred embodiments, Compound 1 and polymer are present in roughly equal amounts, for example each of the polymer and the drug make up about half of the percentage weight of the dispersion. For example, the polymer is present in about 49.5% and the drug is present in about 50%.

20 [0125] In some preferred embodiments, the dispersion further includes other minor ingredients, such as a surfactant (e.g., SLS). In some preferred embodiments, the surfactant is present in less than about 10% of the dispersion, for example less than about 9%, less than about 8%, less than about 7%, less than about 6%, less than about 5%, less than about 4%, less than about 3%, less than about 2%, about 1%, or about 0.5%.

25 [0126] In embodiments including a polymer, the polymer should be present in an amount effective for stabilizing the solid dispersion. Stabilizing includes inhibiting or preventing, the crystallization of Compound 1. Such stabilizing would inhibit the conversion Compound 1 from amorphous to crystalline form. For example, the polymer would prevent at least a portion (e.g., about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 55%, about 60%, about 65%, about 70%,
30 about 75%, or greater) of Compound 1 from converting from an amorphous to a crystalline form. Stabilization can be measured, for example, by measuring the glass transition temperature of the solid dispersion, measuring the rate of relaxation of the amorphous material, or by measuring the solubility or bioavailability of Compound 1.

5 **[0127]** Suitable polymers for use in combination with Compound 1, for example to form a solid dispersion such as an amorphous solid dispersion, should have one or more of the following properties:

[0128] The glass transition temperature of the polymer should have a temperature of no less than about 10-15 °C lower than the glass transition temperature of Compound 1.

10 Preferably, the glass transition temperature of the polymer is greater than the glass transition temperature of Compound 1, and in general at least 50°C higher than the desired storage temperature of the drug product. For example, at least about 100 °C, at least about 105 °C, at least about 105 °C, at least about 110 °C, at least about 120 °C, at least about 130 °C, at least about 140 °C, at least about 150 °C, at least about 160 °C, at least about 160 °C, or greater.

15 **[0129]** The polymer should be relatively non-hygroscopic. For example, the polymer should, when stored under standard conditions, absorb less than about 10% water, for example, less than about 9%, less than about 8%, less than about 7%, less than about 6%, or less than about 5%, less than about 4%, or less than about 3% water. Preferably the polymer will, when stored under standard conditions, be substantially free of absorbed water.

20 **[0130]** The polymer should have similar or better solubility in solvents suitable for spray drying processes relative to that of Compound 1. In preferred embodiments, the polymer will dissolve in one or more of the same solvents or solvent systems as Compound 1. It is preferred that the polymer is soluble in at least one non-hydroxy containing solvent such as methylene chloride, acetone, or a combination thereof.

25 **[0131]** The polymer, when combined with Compound 1, for example in a solid dispersion or in a liquid suspension, should increase the solubility of Compound 1 in aqueous and physiologically relative media either relative to the solubility of Compound 1 in the absence of polymer or relative to the solubility of Compound 1 when combined with a reference polymer. For example, the polymer could increase the solubility of amorphous
30 Compound 1 by reducing the amount of amorphous Compound 1 that converts to crystalline Compound 1, either from a solid amorphous dispersion or from a liquid suspension.

[0132] The polymer should decrease the relaxation rate of the amorphous substance.

[0133] The polymer should increase the physical and/or chemical stability of Compound 1.

35 **[0134]** The polymer should improve the manufacturability of Compound 1.

5 **[0135]** The polymer should improve one or more of the handling, administration or storage properties of Compound 1.

[0136] The polymer should not interact unfavorably with other pharmaceutical components, for example excipients.

10 **[0137]** The suitability of a candidate polymer (or other component) can be tested using the spray drying methods (or other methods) described herein to form an amorphous composition. The candidate composition can be compared in terms of stability, resistance to the formation of crystals, or other properties, and compared to a reference preparation, e.g., a preparation of neat amorphous Compound 1 or crystalline Compound 1. E.g., a candidate composition could be tested to determine whether it inhibits the time to onset of solvent
15 mediated crystallization, or the percent conversion at a given time under controlled conditions, by at least 50 %, 75 %, 100%, or 110% as well as the reference preparation, or a candidate composition could be tested to determine if it has improved bioavailability or solubility relative to crystalline Compound 1.

20 **[0138]** Surfactants

[0139] A solid dispersion or other composition may include a surfactant. A surfactant or surfactant mixture would generally decrease the interfacial tension between the solid dispersion and an aqueous medium. An appropriate surfactant or surfactant mixture may also enhance aqueous solubility and bioavailability of Compound 1 from a solid dispersion. The
25 surfactants for use in connection with the present invention include, but are not limited to, sorbitan fatty acid esters (e.g., Spans®), polyoxyethylene sorbitan fatty acid esters (e.g., Tweens®), sodium lauryl sulfate (SLS), sodium dodecylbenzene sulfonate (SDBS) dioctyl sodium sulfosuccinate (Docusate), dioxycholic acid sodium salt (DOSS), Sorbitan Monostearate, Sorbitan Tristearate, hexadecyltrimethyl ammonium bromide (HTAB), Sodium
30 N-lauroylsarcosine, Sodium Oleate, Sodium Myristate, Sodium Stearate, Sodium Palmitate, Gelucire 44/14, ethylenediamine tetraacetic acid (EDTA), Vitamin E d-alpha tocopheryl polyethylene glycol 1000 succinate (TPGS), Lecithin, MW 677-692, Glutamic acid monosodium monohydrate, Labrasol, PEG 8 caprylic/capric glycerides, Transcutol, diethylene glycol monoethyl ether, Solutol HS-15, polyethylene glycol/hydroxystearate, Taurocholic
35 Acid, Pluronic F68, Pluronic F108, and Pluronic F127 (or any other polyoxyethylene-

5 polyoxypropylene co-polymers (Pluronic®) or saturated polyglycolized glycerides (Gelucirs®). Specific example of such surfactants that may be used in connection with this invention include, but are not limited to, Span 65, Span 25, Tween 20, Capryol 90, Pluronic F108, sodium lauryl sulfate (SLS), Vitamin E TPGS, pluronics and copolymers. SLS is generally preferred.

10 [0140] The amount of the surfactant (e.g., SLS) relative to the total weight of the solid dispersion may be between 0.1-15%. Preferably, it is from about 0.5% to about 10%, more preferably from about 0.5 to about 5%, e.g., about 1%, about 2%, about 3%, about 4%, or about 5%.

15 [0141] In certain embodiments, the amount of the surfactant relative to the total weight of the solid dispersion is at least about 0.1, preferably about 0.5%. In these embodiments, the surfactant would be present in an amount of no more than about 15%, and preferably no more than about 12%, about 11%, about 10%, about 9%, about 8%, about 7%, about 6%, about 5%, about 4%, about 3%, about 2% or about 1%. An embodiment wherein the surfactant is in an amount of about 0.5% by weight is preferred.

20 [0142] Candidate surfactants (or other components) can be tested for suitability for use in the invention in a manner similar to that described for testing polymers.

[0143] Methods of making solid forms of Compound 1

25 [0144] The solid form of Compound 1 can vary depending on the method used to prepare Compound 1. For example, Compound 1 can be prepared using a method to provide crystalline Compound 1, such as Form A or Form B, or Compound 1 can be prepared using a method to provide amorphous Compound 1, for example as a neat preparation or where Compound 1 is a component in a dispersion such as a solid amorphous dispersion (e.g., a dispersion of Compound 1 and a polymer such as a cellulosic polymer e.g., HPMC or
30 HPMCAS or a pyrrolidone polymer such as PVP/VA).

[0145] Form A

[0146] Form A of Compound 1 can be prepared, for example, by heating Compound 1 to at or above its melting point, for example to about 250 °C and then cooling the compound, thereby providing Compound 1 having a solid state of Form A. Form A can be characterized
35 by one or more characteristic peaks as determined using XRPD. For example, Compound 1 as

5 Form A can be identified by the presence of one or peaks at 2θ , including one or more of the following peaks at or about: about 5.0 e.g. 4.99; about 7.8, e.g., 7.75; about 8.5, e.g., 8.46; about 9.2, e.g., 9.21; about 9.9, e.g., 9.92; about 11.9, e.g., 11.93; about 12.6, e.g., 12.64; about 13.9, e.g., 13.88; about 14.9, e.g., 14.91; about 15.6, e.g., 15.58; about 16.5, e.g., 16.46; about 18.1, e.g., 18.09; about 18.5, e.g., 18.52; about 21.7, e.g., 20.65; about 22.0, e.g., 21.95; about
10 23.5, e.g., 23.49; about 25.3, e.g., 25.26; about 28.0, e.g., 28.02; about 29.4, e.g., 29.35; and about 30.9, e.g., 30.85.

[0147] Form B

[0148] Form B of Compound 1 can be prepared, for example, by subjecting a slurry of compound 1 in a solvent to heating and cooling cycles.

15 **[0149]** In some preferred embodiments, the solvent is a solvent where Compound 1 has limited solubility at room temperature, for example, acetone.

[0150] The slurry is subject to a plurality of heat/cool cycles, where the slurry is generally warmed to a temperature above room temperature but below the boiling point of the solvent, for example about 40 °C to about 60 °C, e.g., about 50 °C. The slurry is generally
20 subjected to at least 2 heat/cool cycles, for example, 2, 3, 4, 5, or 6, preferably 5 cycles. Each cycle was timed to last at least about 8 hours (e.g., 4 hours of heating followed by 4 hours at room temperature, 6 hours of heating followed by 6 hours at room temperature, 8 hours of heating followed by 8 hours at room temperature, preferably 12 hours of heating followed by 12 hours at room temperature).

25 **[0151]** In an alternative embodiment crude Compound 1 can be refluxed in as a slurry in acetonitrile (e.g., 27 volumes of acetonitrile) for 24 hours. The mixture is then cooled, e.g., to about room temperature, e.g., about 20 °C. Form B is then isolated, for example, by filtration as a white to off-white. The resulting wet cake is rinsed with acetonitrile (e.g., 5 volumes) and dried under vacuum at 50 °C until a constant weight is attained.

30 **[0152]** Form B can be characterized by one or more characteristic peaks as determined using XRPD. For example, Compound 1 as Form B can be identified by the presence of one or peaks at 2θ , including one or more of the following peaks at or about: about 6.2, e.g., 6.17; about 7.6, e.g., 7.61; about 8.4, e.g., 8.40; about 11.0, e.g., 11.02; about 12.3, e.g., 12.33; about 14.8, e.g., 14.83; about 16.1, e.g., 16.14; about 17.1, e.g., 17.11; about 18.0, e.g., 17.96; about
35 18.6, e.g., 18.55; about 19.4, e.g., 19.43; about 21.1, e.g., 21.05; about 22.6, e.g., 22.56; about

5 23.4, e.g., 23.37; about 23.9, e.g., 23.94; about 24.9, e.g., 24.86; about 25.5, e.g., 25.50; about 26.7, e.g., 26.72; about 27.5, e.g., 27.51; about 29.6, e.g., 29.60; about 33.5, e.g., 33.48; and about 36.8, e.g., 36.78.

[0153] Amorphous Compound 1

10 **[0154]** Amorphous compound 1 can be made using a variety of techniques, including, for example spray drying a solution of Compound 1 to provide amorphous Compound 1, e.g., as a neat solid or as a component of a solid dispersion, said method utilizing spray-drying means to effect said conversion. For example, Amorphous Compound 1 can be made by converting a form of Compound 1, e.g., a crystalline form of Compound 1, such as Form A or
15 Form B, into a substantially amorphous form of Compound 1 by dissolving Compound 1 into a solution and spray drying the solution of Compound 1, thereby converting a form of Compound 1, such as crystalline Compound 1, into amorphous Compound 1. An exemplary process for making amorphous Compound 1 by converting Form B into a substantially amorphous form of Compound 1 is recited in the examples.

20 **[0155]** Any method for obtaining amorphous forms of Compound 1, including neat amorphous Compound 1 and solid amorphous dispersions of Compound 1, can be used including, for example, those described in US 2003/0186952 (see the documents cited therein at paragraph 1092) and US 2003/0185891). In general, methods that could be used include those that involve rapid removal of solvent from a mixture or cooling a molten sample. Such
25 methods include, but are not limited to, rotational evaporation, freeze-drying (i.e., lyophilization), vacuum drying, melt congealing, and melt extrusion. However, a preferred embodiment includes amorphous Compound 1, such as a neat preparation or a solid dispersion obtained by spray-drying. Accordingly, in some embodiments, the amorphous product obtained by spray-drying is further dried, for example, to remove residual solvent.

30 **[0156]** Preparations disclosed herein, e.g., a pharmaceutical composition, can be obtained by spray-drying a mixture comprising Compound 1, a suitable polymer, and an appropriate solvent. Spray drying is a method that involves atomization of a liquid mixture containing, e.g., a solid and a solvent, and removal of the solvent. Atomization can be done, for example, through a nozzle or on a rotating disk.

5 **[0157]** Spray drying is a process that converts a liquid feed to a dried particulate form. Optionally, a secondary drying process such as fluidized bed drying or vacuum drying, may be used to reduce residual solvents to pharmaceutically acceptable levels. Typically, spray-drying involves contacting a highly dispersed liquid suspension or solution, and a sufficient volume of hot air to produce evaporation and drying of the liquid droplets. The preparation to be spray
10 dried can be any solution, coarse suspension, slurry, colloidal dispersion, or paste that may be atomized using the selected spray-drying apparatus. In a standard procedure, the preparation is sprayed into a current of warm filtered air that evaporates the solvent and conveys the dried product to a collector (e.g., a cyclone). The spent air is then exhausted with the solvent, or alternatively the spent air is sent to a condenser to capture and potentially recycle the solvent.
15 Commercially available types of apparatus may be used to conduct the spray-drying. For example, commercial spray dryers are manufactured by Buchi Ltd. and Niro (e.g., the PSD line of spray driers manufactured by Niro) (see, US 2004/0105820; US 2003/0144257).

[0158] Spray-drying typically employs solids loads of material from about 3% to about 30% by weight, (i.e., drug plus and excipients), for example about 4% to about 20% by weight,
20 preferably at least about 10%. In general, the upper limit of solids loads is governed by the viscosity of (e.g., the ability to pump) the resulting solution and the solubility of the components in the solution. Generally, the viscosity of the solution can determine the size of the particle in the resulting powder product.

[0159] Techniques and methods for spray-drying may be found in Perry's Chemical
25 Engineering Handbook, 6th Ed., R.H. Perry, D.W. Green & J.O. Maloney, eds.), McGraw-Hill book co. (1984); and Marshall "Atomization and Spray-Drying" 50, Chem. Eng. Prog. Monogr. Series 2 (1954). In general, the spray-drying is conducted with an inlet temperature of from about 60 °C to about 200 °C, for example, from about 95 °C to about 185 °C, from about 110 °C to about 182 °C, from about 96 °C to about 108 °C, e.g., about 175 °C. The spray-drying is
30 generally conducted with an outlet temperature of from about 30 °C to about 80 °C, for example from about 31 °C to about 72 °C, about 37 °C to about 41 °C e.g., about 60 °C. The atomization flow rate is generally from about 4 kg/h to about 12 kg/h, for example, from about 4.3 kg/h to about 10.5 kg/h, e.g., about 6 kg/h or about 10.5 kg/h. The feed flow rate is generally from about 3 kg/h to about 10 kg/h, for example, from about 3.5 kg/h to about 9.0

5 kg/h, e.g., about 8 kg/h or about 7.1 kg/h. The atomization ratio is generally from about 0.3 to 1.7, e.g., from about 0.5 to 1.5, e.g., about 0.8 or about 1.5.

[0160] Removal of the solvent may require a subsequent drying step, such as tray drying, fluid bed drying (e.g., from about room temperature to about 100 °C), vacuum drying, microwave drying, rotary drum drying or biconical vacuum drying (e.g., from about room
10 temperature to about 200 °C).

[0161] In one embodiment, the solid dispersion is fluid-bed dried.

[0162] In preferred processes, the solvent includes a volatile solvent, for example a solvent having a boiling point of less than about 100 °C. In some embodiments, the solvent includes a mixture of solvents, for example a mixture of volatile solvents or a mixture of
15 volatile and non-volatile solvents. Where mixtures of solvents are used, the mixture can include one or more non-volatile solvents, for example, where the non-volatile solvent is present in the mixture at less than about 15%, e.g., less than about 12%, less than about 10%, less than about 8%, less than about 5%, less than about 3%, or less than about 2%.

[0163] Preferred solvents are those solvents where Compound 1 has a solubility of at least about 10 mg/ml (e.g., at least about 15 mg/ml, 20 mg/ml, 25 mg/ml, 30 mg/ml, 35 mg/ml, 40 mg/ml, 45 mg/ml, 50 mg/ml, or greater). More preferred solvents include those where
20 Compound 1 has a solubility of at least about 50 mg/ml.

[0164] Exemplary solvents that could be tested include acetone, cyclohexane, dichloromethane, N,N-Dimethylacetamide (DMA), N,N-Dimethylformamide (DMF), 1,3
25 Dimethyl-2-imidazolidinone (DMI), dimethyl sulfoxide (DMSO), dioxane, ethyl acetate, ethyl ether, glacial acetic acid (HAc), methyl ethyl ketone (MEK), N-methyl-2-pyrrolidinone (NMP), methyl tert-butyl ether, tetrahydrofuran (THF) and pentane. Exemplary co-solvents include acetone/DMSO, acetone/DMF, acetone/water, MEK/water, THF/water, dioxane/water. In a two solvent system, the solvents can be present in of from about 0.1% to about 99.9%. In
30 some preferred embodiments, water is a co-solvent with acetone where water is present from about 0.1% to about 15%, for example about 9% to about 11%, e.g., about 10%. In some preferred embodiments, water is a co-solvent with MEK where water is present from about 0.1% to about 15%, for example about 9% to about 11%, e.g., about 10%. In some
35 embodiments the solvent solution include three solvents. For example, acetone and water can be mixed with a third solvent such as DMA, DMF, DMI, DMSO, or HAc. In instances where

5 amorphous Compound 1 is a component of a solid amorphous dispersion, preferred solvents dissolve both Compound 1 and the polymer. Suitable solvents include those described above, for example, MEK, acetone, water, and mixtures thereof.

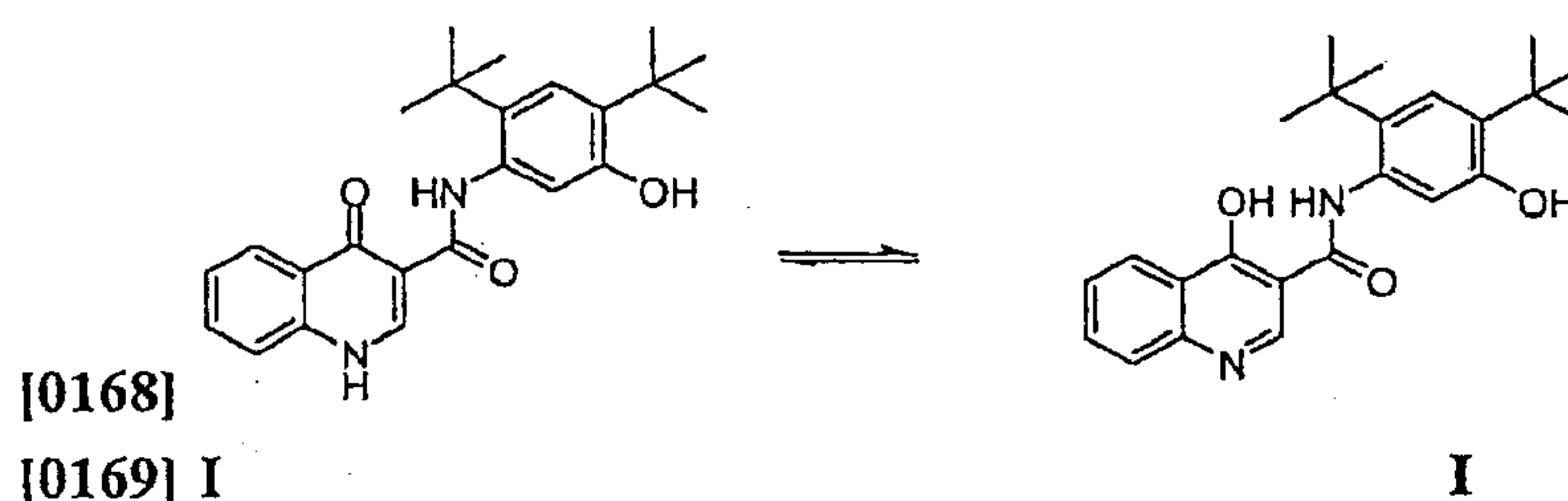
10 [0165] The particle size and the temperature drying range may be modified to prepare an optimal solid dispersion. As would be appreciated by skilled practitioners, a small particle size would lead to improved solvent removal. Applicants have found however, that smaller particles can lead to fluffy particles that, under some circumstances do not provide optimal solid dispersions for downstream processing such as tableting. At higher temperatures, crystallization or chemical degradation of Compound 1 may occur. At lower temperatures, a sufficient amount of the solvent may not be removed. The methods herein provide an optimal
15 particle size and an optimal drying temperature.

[0166] In general, particle size is such that D10 (μm) is less than about 5, e.g., less than about 4.5, less than about 4.0, or less than about 3.5, D50 (μm) is generally less than about 17, e.g., less than about 16, less than about 15, less than about 14, less than about 13, and D90 (μm) is generally less than about 175, e.g., less than about 170, less than about 170, less than about 150, less than about 125, less than about 100, less than about 90, less than about 80, less than about 70, less than about 60, or less than about less than about 50. In general bulk density of the spray dried particles is from about 0.08 g/cc to about 0.20 g/cc, e.g., from about 0.10 to about 0.15 g/cc, e.g., about 0.11 g/cc or about 0.14 g/cc. Tap density of the spray dried particles generally ranges from about 0.08 g/cc to about 0.20 g/cc, e.g., from about 0.10 to
20 about 0.15 g/cc, e.g., about 0.11 g/cc or about 0.14 g/cc, for 10 taps; 0.10 g/cc to about 0.25 g/cc, e.g., from about 0.11 to about 0.21 g/cc, e.g., about 0.15 g/cc, about 0.19 g/cc, or about 0.21 g/cc for 500 taps; 0.15 g/cc to about 0.27 g/cc, e.g., from about 0.18 to about 0.24 g/cc, e.g., about 0.18 g/cc, about 0.19 g/cc, about 0.20 g/cc, or about 0.24 g/cc for 1250 taps; and
25 0.15 g/cc to about 0.27 g/cc, e.g., from about 0.18 to about 0.24 g/cc, e.g., about 0.18 g/cc, about 0.21 g/cc, about 0.23 g/cc, or about 0.24 g/cc for 2500 taps.
30

[0167] Unless otherwise stated, structures depicted herein are also meant to include all isomeric (e.g., enantiomeric, diastereomeric, and geometric (or conformational)) forms of the structure; for example, the R and S configurations for each asymmetric center, (Z) and (E) double bond isomers, and (Z) and (E) conformational isomers. Therefore, single
35 stereochemical isomers as well as enantiomeric, diastereomeric, and geometric (or

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5 conformational) mixtures of the present compounds are within the scope of the invention. All tautomeric forms of the Compound 1 are included herein. E.g., Compound 1 may exist as tautomers, both of which are included herein:



10 [0170] Additionally, unless otherwise stated, structures depicted herein are also meant to include compounds that differ only in the presence of one or more isotopically enriched atoms. For example, compounds of formula (I), wherein one or more hydrogen atoms are replaced deuterium or tritium, or one or more carbon atoms are replaced by a ^{13}C - or ^{14}C -enriched carbon are within the scope of this invention. Such compounds are useful, for

15 example, as analytical tools, or probes in biological assays.

[0171]

[0172] *Pharmaceutically acceptable compositions*

20 [0173] In another aspect of the present invention, pharmaceutically acceptable compositions are provided, wherein these compositions comprise any of the compounds as described herein, and optionally comprise a pharmaceutically acceptable carrier, adjuvant or vehicle.

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[0174] - [0176]

5 [0177] As described above, the pharmaceutically acceptable compositions of the present invention additionally comprise a pharmaceutically acceptable carrier, adjuvant, or vehicle, which, as used herein, includes any and all solvents, diluents, or other liquid vehicle, dispersion or suspension aids, surface active agents, isotonic agents, thickening or emulsifying agents, preservatives, solid binders, lubricants and the like, as suited to the particular dosage
10 form desired. Remington's Pharmaceutical Sciences, Sixteenth Edition, E. W. Martin (Mack Publishing Co., Easton, Pa., 1980) discloses various carriers used in formulating pharmaceutically acceptable compositions and known techniques for the preparation thereof. Except insofar as any conventional carrier medium is incompatible with the compounds of the invention, such as by producing any undesirable biological effect or otherwise interacting in a
15 deleterious manner with any other component(s) of the pharmaceutically acceptable composition, its use is contemplated to be within the scope of this invention. Some examples of materials which can serve as pharmaceutically acceptable carriers include, but are not limited to, ion exchangers, alumina, aluminum stearate, lecithin, serum proteins, such as human serum albumin, buffer substances such as phosphates, glycine, sorbic acid, or potassium
20 sorbate, partial glyceride mixtures of saturated vegetable fatty acids, water, salts or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium hydrogen phosphate, sodium chloride, zinc salts, colloidal silica, magnesium trisilicate, polyvinyl pyrrolidone, polyacrylates, waxes, polyethylene-polyoxypropylene-block polymers, wool fat, sugars such as lactose, glucose and sucrose; starches such as corn starch and potato starch;
25 cellulose and its derivatives such as sodium carboxymethyl cellulose, ethyl cellulose and cellulose acetate; powdered tragacanth; malt; gelatin; talc; excipients such as cocoa butter and suppository waxes; oils such as peanut oil, cottonseed oil; safflower oil; sesame oil; olive oil; corn oil and soybean oil; glycols; such a propylene glycol or polyethylene glycol; esters such as ethyl oleate and ethyl laurate; agar; buffering agents such as magnesium hydroxide and
30 aluminum hydroxide; alginic acid; pyrogen-free water; isotonic saline; Ringer's solution; ethyl alcohol, and phosphate buffer solutions, as well as other non-toxic compatible lubricants such as sodium lauryl sulfate and magnesium stearate, as well as coloring agents, releasing agents, coating agents, sweetening, flavoring and perfuming agents, preservatives and antioxidants can also be present in the composition, according to the judgment of the formulator.

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[0178] - [0181]

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[0182] - [0185]

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[0186] - [0188]

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[0189]

[0190] Liquid dosage forms for oral administration include, but are not limited to, pharmaceutically acceptable emulsions, microemulsions, solutions, suspensions, syrups and elixirs. In addition to the active compounds, the liquid dosage forms may contain inert
5 diluents commonly used in the art such as, for example, water or other solvents, solubilizing agents and emulsifiers such as ethyl alcohol, isopropyl alcohol, ethyl carbonate, ethyl acetate, benzyl alcohol, benzyl benzoate, propylene glycol, 1,3-butylene glycol, dimethylformamide, oils (in particular, cottonseed, groundnut, corn, germ, olive, castor, and sesame oils), glycerol, tetrahydrofurfuryl alcohol, polyethylene glycols and fatty acid esters of sorbitan, and mixtures
10 thereof. Besides inert diluents, the oral compositions can also include adjuvants such as wetting agents, emulsifying and suspending agents, sweetening, flavoring, and perfuming agents.

5 **[0191]** Injectable preparations, for example, sterile injectable aqueous or oleaginous suspensions may be formulated according to the known art using suitable dispersing or wetting agents and suspending agents. The sterile injectable preparation may also be a sterile injectable solution, suspension or emulsion in a nontoxic parenterally acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may
10 be employed are water, Ringer's solution, U.S.P. and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose any bland fixed oil can be employed including synthetic mono- or diglycerides. In addition, fatty acids such as oleic acid are used in the preparation of injectables.

15 **[0192]** The injectable formulations can be sterilized, for example, by filtration through a bacterial-retaining filter, or by incorporating sterilizing agents in the form of sterile solid compositions which can be dissolved or dispersed in sterile water or other sterile injectable medium prior to use.

20 **[0193]** In order to prolong the effect of a compound of the present invention, it is often desirable to slow the absorption of the compound from subcutaneous or intramuscular injection. This may be accomplished by the use of a liquid suspension of crystalline or amorphous material with poor water solubility. The rate of absorption of the compound then depends upon its rate of dissolution that, in turn, may depend upon crystal size and crystalline form. Alternatively, delayed absorption of a parenterally administered compound form is
25 accomplished by dissolving or suspending the compound in an oil vehicle. Injectable depot forms are made by forming microencapsule matrices of the compound in biodegradable polymers such as polylactide-polyglycolide. Depending upon the ratio of compound to polymer and the nature of the particular polymer employed, the rate of compound release can be controlled. Examples of other biodegradable polymers include poly(orthoesters) and
30 poly(anhydrides). Depot injectable formulations are also prepared by entrapping the compound in liposomes or microemulsions that are compatible with body tissues.

[0194] Compositions for rectal or vaginal administration are preferably suppositories which can be prepared by mixing the compounds of this invention with suitable non-irritating excipients or carriers such as cocoa butter, polyethylene glycol or a suppository wax which are

5 solid at ambient temperature but liquid at body temperature and therefore melt in the rectum or vaginal cavity and release the active compound.

[0195] Solid dosage forms for oral administration include capsules, tablets, pills, powders, and granules. In such solid dosage forms, the active compound is mixed with at least one inert, pharmaceutically acceptable excipient or carrier such as sodium citrate or dicalcium phosphate and/or a) fillers or extenders such as starches, lactose, sucrose, glucose, mannitol, 10 and silicic acid, b) binders such as, for example, carboxymethylcellulose, alginates, gelatin, polyvinylpyrrolidinone, sucrose, and acacia, c) humectants such as glycerol, d) disintegrating agents such as agar--agar, calcium carbonate, potato or tapioca starch, alginic acid, certain silicates, and sodium carbonate, e) solution retarding agents such as paraffin, f) absorption 15 accelerators such as quaternary ammonium compounds, g) wetting agents such as, for example, cetyl alcohol and glycerol monostearate, h) absorbents such as kaolin and bentonite clay, and i) lubricants such as talc, calcium stearate, magnesium stearate, solid polyethylene glycols, sodium lauryl sulfate, and mixtures thereof. In the case of capsules, tablets and pills, the dosage form may also comprise buffering agents.

20 [0196] Solid compositions of a similar type may also be employed as fillers in soft and hard-filled gelatin capsules using such excipients as lactose or milk sugar as well as high molecular weight polyethylene glycols and the like. The solid dosage forms of tablets, dragees, capsules, pills, and granules can be prepared with coatings and shells such as enteric coatings and other coatings well known in the pharmaceutical formulating art. They may optionally 25 contain opacifying agents and can also be of a composition that they release the active ingredient(s) only, or preferentially, in a certain part of the intestinal tract, optionally, in a delayed manner. Examples of embedding compositions that can be used include polymeric substances and waxes. Solid compositions of a similar type may also be employed as fillers in soft and hard-filled gelatin capsules using such excipients as lactose or milk sugar as well as 30 high molecular weight polyethylene glycols and the like.

[0197] The active compounds can also be in microencapsulated form with one or more excipients as noted above. The solid dosage forms of tablets, dragees, capsules, pills, and granules can be prepared with coatings and shells such as enteric coatings, release controlling coatings and other coatings well known in the pharmaceutical formulating art. In such solid 35 dosage forms the active compound may be admixed with at least one inert diluent such as

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5 sucrose, lactose or starch. Such dosage forms may also comprise, as is normal practice,
additional substances other than inert diluents, e.g., tableting lubricants and other tableting aids
such a magnesium stearate and microcrystalline cellulose. In the case of capsules, tablets and
pills, the dosage forms may also comprise buffering agents. They may optionally contain
opacifying agents and can also be of a composition that they release the active ingredient(s)
10 only, or preferentially, in a certain part of the intestinal tract, optionally, in a delayed manner.
Examples of embedding compositions that can be used include polymeric substances and
waxes.

[0198] Dosage forms for topical or transdermal administration of a compound of this
invention include ointments, pastes, creams, lotions, gels, powders, solutions, sprays, inhalants
15 or patches. The active component is admixed under sterile conditions with a pharmaceutically
acceptable carrier and any needed preservatives or buffers as may be required. Ophthalmic
formulation, eardrops, and eye drops are also contemplated as being within the scope of this
invention. Additionally, the present invention contemplates the use of transdermal patches,
which have the added advantage of providing controlled delivery of a compound to the body.
20 Such dosage forms are prepared by dissolving or dispensing the compound in the proper
medium. Absorption enhancers can also be used to increase the flux of the compound across
the skin. The rate can be controlled by either providing a rate controlling membrane or by
dispersing the compound in a polymer matrix or gel.

[0199]

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[0200] - [0202]

5 **[0203]** In order that the invention described herein may be more fully understood, the following examples are set forth. It should be understood that these examples are for illustrative purposes only and are not to be construed as limiting this invention in any manner.

[0204] EXAMPLES

10 **[0205] Methods & Materials**

[0206] Differential Scanning Calorimetry (DSC)

[0207] The Differential scanning calorimetry (DSC) data of Form A, Form B, and amorphous Compound 1 were collected using a DSC Q100 V9.6 Build 290 (TA Instruments, New Castle, DE). Temperature was calibrated with indium and heat capacity was calibrated with sapphire. Samples of 3-6 mg were weighed into aluminum pans that were crimped using lids with 1 pin hole. The samples were scanned from 25°C to 350°C at a heating rate of 10°C/min and with a nitrogen gas purge of 50 ml/min. Data were collected by Thermal Advantage Q Series™ version 2.2.0.248 software and analyzed by Universal Analysis software version 4.1D (TA Instruments, New Castle, DE). The reported numbers represent single analyses.

[0208] Thermogravimetric analysis (TGA)

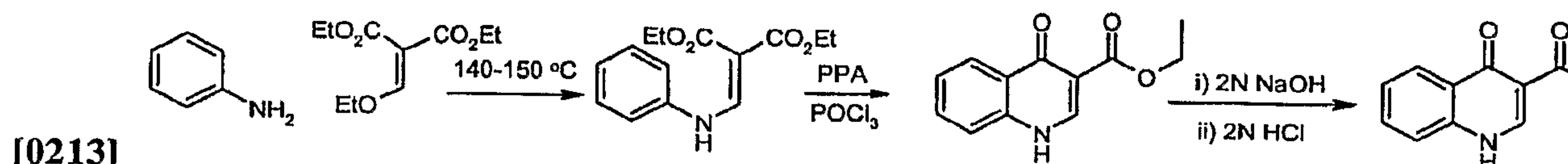
[0209] Thermal gravimetric analysis (TGA) was performed with a TGA Q500 V6.3 Build 189 (TA Instruments, New Castle, DE) was used for TGA measurement. Temperature was equilibrated by Curie point with nickel. Samples of 10-20 mg were scanned from 25°C to 350°C at a heating rate of 10°C/min. A nitrogen gas balance purge of 10 ml/min and a sample purge of 90 ml/min were used. Data were collected by Thermal Advantage Q Series™ software version 2.2.0.248 and analyzed by Universal Analysis software version 4.1D (TA Instruments, New Castle, DE). The reported numbers represent single analyses.

[0210] XRPD (X-ray Powder Diffraction)

30 **[0211]** The X-Ray diffraction (XRD) data of Form A, Form B, and amorphous Compound 1 were collected on a Bruker D8 DISCOVER with GADDS powder diffractometer with HI-STAR 2-dimensional detector and a flat graphite monochromator. Cu sealed tube with K α radiation was used at 40 kV, 35mA. The samples were placed on zero-background silicon wafers at 25°C. For each sample, two data frames were collected at 120 seconds each at 2

different 2θ angles: 8° and 26° . The frames data were integrated with GADDS software and merged with DIFFRACT^{plus}EVA software.

[0212] Synthesis of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide (Compound 1):



[0214] 2-Phenylaminomethylene-malonic acid diethyl ester

[0215] A mixture of aniline (25.6 g, 0.275 mol) and diethyl 2-(ethoxymethylene)malonate (62.4 g, 0.288 mol) was heated at 140-150 °C for 2 h. The mixture was cooled to room temperature and dried under reduced pressure to afford 2-phenylaminomethylene-malonic acid diethyl ester as a solid, which was used in the next step without further purification. ¹H NMR (DMSO-*d*₆) δ 11.00 (d, 1H), 8.54 (d, $J = 13.6$ Hz, 1H), 7.36-7.39 (m, 2H), 7.13-7.17 (m, 3H), 4.17-4.33 (m, 4H), 1.18-1.40 (m, 6H).

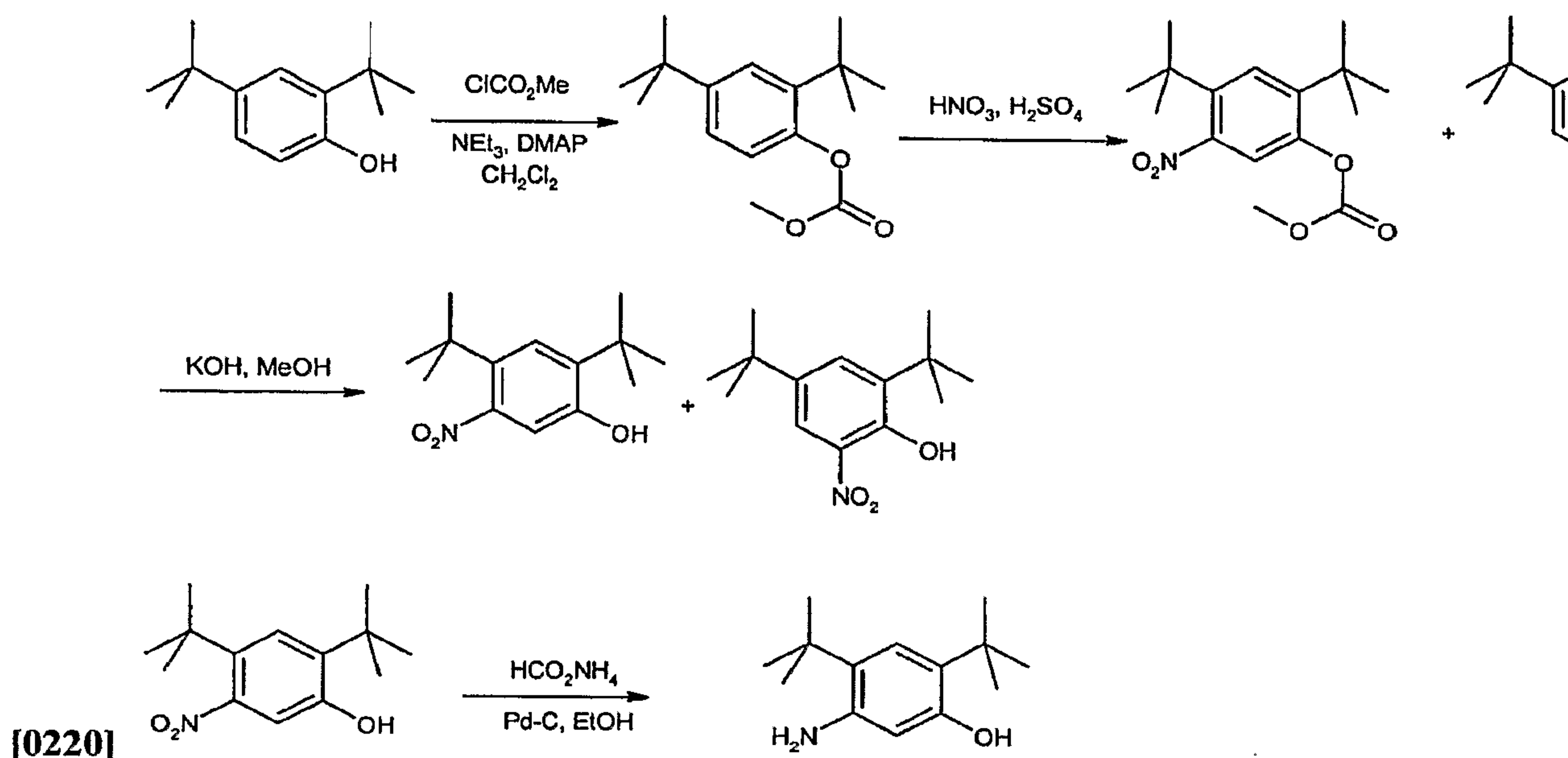
[0216] 4-Hydroxyquinoline-3-carboxylic acid ethyl ester

[0217] A 1 L three-necked flask fitted with a mechanical stirrer was charged with 2-phenylaminomethylene-malonic acid diethyl ester (26.3 g, 0.100 mol), polyphosphoric acid (270 g) and phosphoryl chloride (750 g). The mixture was heated to 70 °C and stirred for 4 h. The mixture was cooled to room temperature and filtered. The residue was treated with aqueous Na₂CO₃ solution, filtered, washed with water and dried. 4-Hydroxyquinoline-3-carboxylic acid ethyl ester was obtained as a pale brown solid (15.2 g, 70%). The crude product was used in next step without further purification.

[0218] 4-Oxo-1,4-dihydroquinoline-3-carboxylic acid

[0219] 4-Hydroxyquinoline-3-carboxylic acid ethyl ester (15 g, 69 mmol) was suspended in sodium hydroxide solution (2N, 150 mL) and stirred for 2 h at reflux. After cooling, the mixture was filtered, and the filtrate was acidified to pH 4 with 2N HCl. The

5 resulting precipitate was collected via filtration, washed with water and dried under vacuum to give 4-oxo-1,4-dihydroquinoline-3-carboxylic acid as a pale white solid (10.5 g, 92 %). ¹H NMR (DMSO-*d*₆) δ 15.34 (s, 1 H), 13.42 (s, 1 H), 8.89 (s, 1H), 8.28 (d, *J* = 8.0 Hz, 1H), 7.88 (m, 1H), 7.81 (d, *J* = 8.4 Hz, 1H), 7.60 (m, 1H).



[0221] Carbonic acid 2,4-di-*tert*-butyl-phenyl ester methyl ester

15 [0222] Methyl chloroformate (58 mL, 750 mmol) was added dropwise to a solution of 2,4-di-*tert*-butyl-phenol (103.2 g, 500 mmol), Et₃N (139 mL, 1000 mmol) and DMAP (3.05 g, 25 mmol) in dichloromethane (400 mL) cooled in an ice-water bath to 0 °C. The mixture was allowed to warm to room temperature while stirring overnight, then filtered through silica gel (approx. 1L) using 10% ethyl acetate – hexanes (~ 4 L) as the eluent. The combined filtrates were concentrated to yield carbonic acid 2,4-di-*tert*-butyl-phenyl ester methyl ester as a yellow oil (132 g, quant.). ¹H NMR (400 MHz, DMSO-*d*₆) δ 7.35 (d, *J* = 2.4 Hz, 1H), 7.29 (dd, *J* = 8.5, 2.4 Hz, 1H), 7.06 (d, *J* = 8.4 Hz, 1H), 3.85 (s, 3H), 1.30 (s, 9H), 1.29 (s, 9H).

20

[0223] Carbonic acid 2,4-di-*tert*-butyl-5-nitro-phenyl ester methyl ester and Carbonic acid 2,4-di-*tert*-butyl-6-nitro-phenyl ester methyl ester

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5 **[0224]** To a stirring mixture of carbonic acid 2,4-di-*tert*-butyl-phenyl ester methyl ester (4.76 g, 180 mmol) in conc. sulfuric acid (2 mL), cooled in an ice-water bath, was added a cooled mixture of sulfuric acid (2 mL) and nitric acid (2 mL). The addition was done slowly so that the reaction temperature did not exceed 50 °C. The reaction was allowed to stir for 2 h while warming to room temperature. The reaction mixture was then added to ice-water and
10 extracted into diethyl ether. The ether layer was dried (MgSO₄), concentrated and purified by column chromatography (0 – 10% ethyl acetate – hexanes) to yield a mixture of carbonic acid 2,4-di-*tert*-butyl-5-nitro-phenyl ester methyl ester and carbonic acid 2,4-di-*tert*-butyl-6-nitro-phenyl ester methyl ester as a pale yellow solid (4.28 g), which was used directly in the next step.

15

[0225] 2,4-Di-*tert*-butyl-5-nitro-phenol and 2,4-Di-*tert*-butyl-6-nitro-phenol

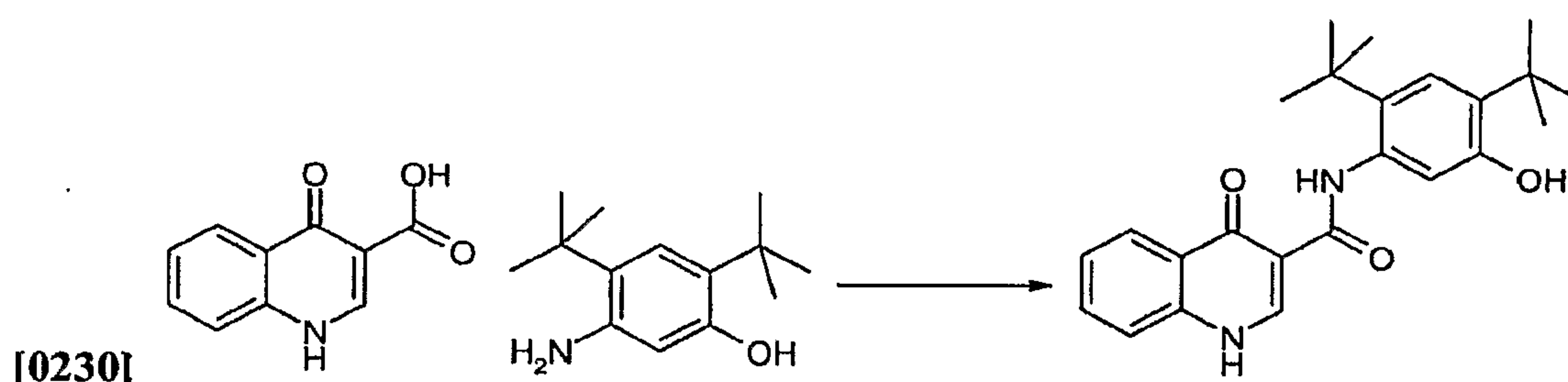
[0226] The mixture of carbonic acid 2,4-di-*tert*-butyl-5-nitro-phenyl ester methyl ester and carbonic acid 2,4-di-*tert*-butyl-6-nitro-phenyl ester methyl ester (4.2 g, 14.0 mmol) was dissolved in MeOH (65 mL) before KOH (2.0 g, 36 mmol) was added. The mixture was stirred
20 at room temperature for 2 h. The reaction mixture was then made acidic (pH 2-3) by adding conc. HCl and partitioned between water and diethyl ether. The ether layer was dried (MgSO₄), concentrated and purified by column chromatography (0 – 5 % ethyl acetate – hexanes) to provide 2,4-di-*tert*-butyl-5-nitro-phenol (1.31 g, 29% over 2 steps) and 2,4-di-*tert*-butyl-6-nitro-phenol. 2,4-Di-*tert*-butyl-5-nitro-phenol: ¹H NMR (400 MHz, DMSO-*d*₆) δ
25 10.14 (s, 1H, OH), 7.34 (s, 1H), 6.83 (s, 1H), 1.36 (s, 9H), 1.30 (s, 9H). 2,4-Di-*tert*-butyl-6-nitro-phenol: ¹H NMR (400 MHz, CDCl₃) δ 11.48 (s, 1H), 7.98 (d, *J* = 2.5 Hz, 1H), 7.66 (d, *J* = 2.4 Hz, 1H), 1.47 (s, 9H), 1.34 (s, 9H).

[0227] 5-Amino-2,4-di-*tert*-butyl-phenol

30 **[0228]** To a refluxing solution of 2,4-di-*tert*-butyl-5-nitro-phenol (1.86 g, 7.40 mmol) and ammonium formate (1.86 g) in ethanol (75 mL) was added Pd-5% wt. on activated carbon (900 mg). The reaction mixture was stirred at reflux for 2 h, cooled to room temperature and filtered through CeliteTM. The Celite was washed with methanol and the combined filtrates were concentrated to yield 5-amino-2,4-di-*tert*-butyl-phenol as a grey solid (1.66 g, quant.). ¹H
35 NMR (400 MHz, DMSO-*d*₆) δ 8.64 (s, 1H, OH), 6.84 (s, 1H), 6.08 (s, 1H), 4.39 (s, 2H, NH₂),

5 1.27 (m, 18H); HPLC ret. time 2.72 min, 10-99 % CH₃CN, 5 min run; ESI-MS 222.4 m/z [M+H]⁺.

10 [0229] N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide



15 [0231] To a suspension of 4-oxo-1,4-dihydroquinolin-3-carboxylic acid (35.5 g, 188 mmol) and HBTU (85.7 g, 226 mmol) in DMF (280 mL) was added Et₃N (63.0 mL, 451 mmol) at ambient temperature. The mixture became homogeneous and was allowed to stir for 10 min before 5-amino-2,4-di-*tert*-butylphenol (50.0 g, 226 mmol) was added in small portions. The mixture was allowed to stir overnight at ambient temperature. The mixture became heterogeneous over the course of the reaction. After all of the acid was consumed (LC-MS analysis, MH⁺ 190, 1.71 min), the solvent was removed *in vacuo*. EtOH was added to the orange solid material to produce a slurry. The mixture was stirred on a rotovap (bath temperature 65 °C) for 15 min without placing the system under vacuum. The mixture was filtered and the captured solid was washed with hexanes to provide a white solid that was the EtOH crystalate. Et₂O was added to the material obtained above until a slurry was formed. The mixture was stirred on a rotovapor (bath temperature 25 °C) for 15 min without placing the system under vacuum. The mixture was filtered and the solid captured. This procedure was performed a total of five times. The solid obtained after the fifth precipitation was placed under vacuum overnight to provide 8 N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide as a white powdery solid (38 g, 52%).

25 [0232] HPLC ret. time 3.45 min, 10-99% CH₃CN, 5 min run; ¹H NMR (400 MHz, DMSO-*d*₆) δ 12.88 (s, 1H), 11.83 (s, 1H), 9.20 (s, 1H), 8.87 (s, 1H), 8.33 (dd, J = 8.2, 1.0 Hz,

30

1H), 7.83-7.79 (m, 1H), 7.76 (d, J = 7.7 Hz, 1H), 7.54-7.50 (m, 1H), 7.17 (s, 1H), 7.10 (s, 1H), 1.38 (s, 9H), 1.37 (s, 9H); ESI-MS 393.3 m/z [M+H]⁺.

[0233] Set forth below is the characterizing data for Compound 1:

[0242] **Table 2**

md No.	C-MS +1	C-RT in
	93.2	.71

[0244] The XRPD spectrum of Compound 1 is shown in FIG. 1.

[0245] ¹H NMR data for Compound 1 is shown in FIG. 2.

[0246] The DSC trace of Compound 1 is shown in FIG. 3.

[0247] **Preparation of Form A**

[0248] Form A was obtained by heating Compound 1 as a solid to 250°C and cooling to room temperature. The DSC thermogram on Compound 1 (See FIG. 6) shows that the compound undergoes a melt with an onset temperature of 195°C, followed by a re-crystallisation with onset at 220°C.

[0249] The XRPD spectrum of Form A is shown in FIG. 4.

[0250] The DSC data for Form A is shown in FIG. 5.

[0251] The TGA trace for Form A is shown in FIG. 6.

[0252] **Preparation of Form B**

[0253] Crude Compound 1 was a slurry in refluxing acetonitrile (27 volumes) for 24 hours. After 24 hours, the mixture was allowed to cool to 20 °C. Form B was isolated by filtration as a white to off-white. The wet cake was rinsed with acetonitrile (5 volumes) and dried under vacuum at 50°C until a constant weight is attained, thereby providing Form B.

[0254] The XRPD spectrum of Form B is shown in FIG. 7.

[0255] The DSC trace of Form B is shown in FIG. 8.

[0256] The TGA trace for Form B is shown in FIG. 9.

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5 [0257] Single crystal data was obtained for Form B, providing detail additional detail about the crystal structure, including lattice size and packing.

[0258] Crystal preparation:

10 [0259] 1 g of Compound 1 was added to 10 ml of isopropanol acetate. The suspension was heated and remained at 60°C for 3 hours. The suspension was cooled to room temperature and remained stirred overnight. The suspended solid was filtered and washed with isopropanol acetate. The collected solid was dried under vacuum at room temperature. 300 mg of the dried solid was dissolved in 5 ml of 10% aqueous ethyl acetate solution. The solution was heated to 70°C for 10 minutes before it was cooled to room temperature. Over time, crystals grew in the vial.

15

[0260] Experimental:

20 [0261] A single crystal of Form B was mounted on a MicroMount loop and centered on a Bruker Apex IITM diffractometer that was equipped with a sealed copper X-ray tube and Apex IITM CCD detector. Initially, 3 sets of 40 frames were collected to determine a preliminary unit cell. Subsequently a full data set consisting of 15 scans and 6084 frames was acquired. Data collection was performed at 100 K. Data were integrated and scaled using Apex IITM software from Bruker AXS. Integration and scaling resulted in 7528 reflections, 3071 of which were unique [$R(int) = 0.0466$]. Structure was solved by direct methods in space group $P2_1$ using SHELXTLTM software. Refinement was performed with full-matrix least-square method on F^2 using SHELXTLTM software as well. Altogether 375 parameters were used in refinement resulting in reflection to parameter ratio of 8.19. The final refinement afforded a chiral structure with a Flack parameter of 0.0(3). The final refinement index was $wR2 = 0.1242$ and $R1 = 0.0663$ ($wR2 = 0.1137$ and $R1 = 0.0482$ for reflections with $I > 2$ sigma (I)).

25 [0262] A conformational picture of Form B is provided in FIGURE 10.

30

[0263]

Table 1. Crystal data and structure refinement for Compound 1.

Identification code	Compound 1
Empirical formula	C ₂₄ H ₂₈ N ₂ O ₃
35 Formula weight	392.48
Temperature	100(2) K

5	Wavelength	1.54178 Å	
	Crystal system	monoclinic	
	Space group	P2 ₁	
	Unit cell dimensions	a = 11.8011(7) Å	α = 90°.
		b = 5.9819(3) Å	β = 105.110(4)°.
10		c = 14.7974(8) Å	γ = 90°.
	Volume	1008.48(10) Å ³	
	Z	2	
	Density (calculated)	1.293 Mg/m ³	
	Absorption coefficient	0.681 mm ⁻¹	
15	F(000)	420	
	Crystal size	0.20 x 0.08 x 0.08 mm ³	
	Theta range for data collection	3.09 to 68.67°.	
	Index ranges	-14 ≤ h ≤ 14, -7 ≤ k ≤ 7, -14 ≤ l ≤ 17	
	Reflections collected	7528	
20	Independent reflections	3071 [R(int) = 0.0466]	
	Completeness to theta = 68.67°	94.6 %	
	Max. and min. transmission	0.9475 and 0.8758	
	Refinement method	Full-matrix least-squares on F ²	
	Data / restraints / parameters	3071 / 1 / 375	
25	Goodness-of-fit on F ²	1.001	
	Final R indices [I > 2σ(I)]	R1 = 0.0482, wR2 = 0.1137	
	R indices (all data)	R1 = 0.0663, wR2 = 0.1242	
	Absolute structure parameter	0.0(3)	
	Extinction coefficient	0.0008(6)	
30	Largest diff. peak and hole	0.200 and -0.218 e.Å ⁻³	

5 Table 2. Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for Compound 1. $U(\text{eq})$ is defined as one third of the trace of the orthogonalized U^{ij} tensor.

		x	y	z	U(eq)
10	N(1)	11624(2)	-530(5)	8667(2)	33(1)
	C(3)	10407(3)	2650(6)	8133(2)	31(1)
	C(4)	10335(3)	2115(6)	7158(2)	30(1)
	C(5)	11006(3)	150(6)	7013(2)	31(1)
	C(2)	11034(3)	1269(6)	8830(2)	32(1)
15	C(8)	12233(3)	-3643(7)	6701(3)	38(1)
	C(7)	11610(3)	-2371(7)	5947(3)	37(1)
	C(6)	11015(3)	-530(6)	6093(2)	35(1)
	C(9)	12255(3)	-3039(7)	7618(2)	36(1)
	C(11)	9786(3)	4549(6)	8431(2)	32(1)
20	C(15)	6468(3)	9414(6)	7354(2)	30(1)
	C(19)	7049(3)	7025(6)	6127(2)	31(1)
	C(18)	8461(3)	8580(6)	8706(2)	32(1)
	C(13)	8275(3)	7448(6)	7859(2)	29(1)
	C(16)	6578(3)	10442(6)	8223(2)	31(1)
25	C(17)	7639(3)	10044(6)	8889(2)	30(1)
	C(14)	7271(3)	7965(6)	7130(2)	30(1)
	C(23)	5586(3)	11841(6)	8438(2)	34(1)
	C(21)	8075(3)	7722(7)	5705(2)	35(1)
	C(22)	5943(3)	8034(7)	5474(2)	35(1)
30	C(20)	6879(3)	4481(7)	6096(3)	37(1)
	C(24)	4478(3)	11888(7)	7605(3)	39(1)
	C(25)	5981(3)	14254(7)	8672(3)	39(1)
	C(26)	5207(3)	10760(7)	9264(3)	37(1)
	N(12)	9082(2)	5775(5)	7752(2)	31(1)
35	O(11)	9923(2)	4910(4)	9289(2)	37(1)
	O(4)	9748(2)	3206(4)	6485(2)	35(1)
	O(17)	7888(2)	11078(5)	9758(2)	37(1)
	C(10)	11644(3)	-1165(6)	7761(2)	32(1)

5 Table 3. Bond lengths [$\text{\AA}$] and angles [$^\circ$] for Compound 1.

Bond	Length ($^\circ\text{\AA}$)
N(1)-C(2)	1.337(5)
N(1)-C(10)	1.400(5)
C(3)-C(2)	1.377(5)
C(3)-C(4)	1.458(4)
C(3)-C(11)	1.481(5)
C(4)-O(4)	1.240(4)
C(4)-C(5)	1.465(5)
C(5)-C(10)	1.406(5)
C(5)-C(6)	1.423(5)
C(8)-C(7)	1.391(5)
C(8)-C(9)	1.398(5)
C(7)-C(6)	1.353(5)
C(9)-C(10)	1.379(5)
C(11)-O(11)	1.255(4)
C(11)-N(12)	1.343(4)
C(15)-C(14)	1.387(5)
C(15)-C(16)	1.399(5)
C(19)-C(22)	1.531(4)
C(19)-C(20)	1.534(5)
C(19)-C(14)	1.544(4)
C(19)-C(21)	1.558(5)
C(18)-C(17)	1.385(5)
C(18)-C(13)	1.390(5)
C(13)-C(14)	1.413(4)
C(13)-N(12)	1.418(4)
C(16)-C(17)	1.397(4)
C(16)-C(23)	1.539(5)
C(17)-O(17)	1.387(4)
C(23)-C(25)	1.528(5)
C(23)-C(24)	1.546(5)
C(23)-C(26)	1.548(5)

Bond	Angle (deg)
C(2)-N(1)-C(10)	122.0(3)
C(2)-C(3)-C(4)	119.4(3)
C(2)-C(3)-C(11)	116.6(3)
C(4)-C(3)-C(11)	123.9(3)
O(4)-C(4)-C(3)	123.8(3)
O(4)-C(4)-C(5)	120.9(3)
C(3)-C(4)-C(5)	115.3(3)
C(10)-C(5)-C(6)	117.2(3)
C(10)-C(5)-C(4)	122.2(3)
C(6)-C(5)-C(4)	120.6(3)
N(1)-C(2)-C(3)	123.4(3)
C(7)-C(8)-C(9)	120.6(4)
C(6)-C(7)-C(8)	120.3(4)
C(7)-C(6)-C(5)	121.2(3)
C(10)-C(9)-C(8)	118.7(3)
O(11)-C(11)-N(12)	123.7(3)
O(11)-C(11)-C(3)	119.4(3)
N(12)-C(11)-C(3)	117.0(3)
C(14)-C(15)-C(16)	126.1(3)
C(22)-C(19)-C(20)	106.8(3)
C(22)-C(19)-C(14)	111.5(3)
C(20)-C(19)-C(14)	112.2(3)
C(22)-C(19)-C(21)	105.4(3)
C(20)-C(19)-C(21)	111.3(3)
C(14)-C(19)-C(21)	109.4(3)
C(17)-C(18)-C(13)	122.0(3)
C(18)-C(13)-C(14)	119.0(3)
C(18)-C(13)-N(12)	119.4(3)
C(14)-C(13)-N(12)	121.5(3)
C(17)-C(16)-C(15)	115.1(3)
C(17)-C(16)-C(23)	122.4(3)

Bond	Angle (deg)
C(15)-C(16)-C(23)	122.4(3)
C(18)-C(17)-O(17)	118.2(3)
C(18)-C(17)-C(16)	120.9(3)
O(17)-C(17)-C(16)	120.8(3)
C(15)-C(14)-C(13)	116.3(3)
C(15)-C(14)-C(19)	120.1(3)
C(13)-C(14)-C(19)	123.5(3)
C(25)-C(23)-C(16)	110.9(3)
C(25)-C(23)-C(24)	107.9(3)
C(16)-C(23)-C(24)	112.1(3)
C(25)-C(23)-C(26)	110.5(3)
C(16)-C(23)-C(26)	109.2(3)
C(24)-C(23)-C(26)	106.1(3)
C(11)-N(12)-C(13)	127.2(3)
C(9)-C(10)-N(1)	120.5(3)
C(9)-C(10)-C(5)	121.9(3)
N(1)-C(10)-C(5)	117.6(3)

10 Symmetry transformations used to generate equivalent atoms:

5 Table 4. Anisotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for Compound 1. The anisotropic displacement factor exponent takes the form: $-2\pi^2 [h^2 a^{*2} U^{11} + \dots + 2 h k a^* b^* U^{12}]$

		U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
10	N(1)	42(1)	41(2)	14(2)	5(1)	4(1)	3(1)
	C(3)	34(2)	40(2)	16(2)	-1(1)	4(1)	-4(1)
	C(4)	34(2)	38(2)	17(2)	0(1)	4(1)	-1(1)
	C(5)	34(2)	42(2)	17(2)	-2(1)	6(1)	-6(1)
	C(2)	37(2)	42(2)	16(2)	1(1)	5(1)	1(2)
15	C(8)	44(2)	41(2)	30(2)	-4(2)	10(1)	5(2)
	C(7)	46(2)	44(2)	22(2)	-4(1)	9(1)	-5(2)
	C(6)	41(2)	40(2)	23(2)	1(2)	9(1)	-1(2)
	C(9)	41(2)	40(2)	24(2)	5(1)	4(1)	3(2)
	C(11)	35(2)	41(2)	18(2)	1(1)	4(1)	-4(2)
20	C(15)	37(2)	37(2)	15(2)	4(1)	3(1)	1(1)
	C(19)	38(2)	38(2)	14(2)	2(1)	5(1)	4(1)
	C(18)	36(2)	42(2)	14(2)	4(1)	0(1)	0(1)
	C(13)	39(2)	34(2)	16(2)	2(1)	9(1)	-3(1)
	C(16)	46(2)	29(2)	19(2)	1(1)	10(1)	-3(1)
25	C(17)	43(2)	33(2)	14(2)	-2(1)	7(1)	-6(1)
	C(14)	38(2)	38(2)	11(2)	1(1)	3(1)	-3(2)
	C(23)	46(2)	40(2)	20(2)	2(1)	13(1)	3(2)
	C(21)	51(2)	45(2)	8(2)	2(1)	7(1)	0(2)
	C(22)	44(2)	41(2)	16(2)	-7(1)	1(1)	2(2)
30	C(20)	40(2)	46(2)	20(2)	-1(2)	3(1)	1(2)
	C(24)	44(2)	49(2)	24(2)	-2(2)	10(1)	5(2)
	C(25)	52(2)	43(2)	24(2)	3(1)	12(2)	9(2)
	C(26)	48(2)	40(2)	24(2)	1(1)	14(1)	0(2)
	N(12)	40(1)	41(2)	12(2)	0(1)	5(1)	0(1)
35	O(11)	48(1)	47(1)	13(1)	1(1)	4(1)	5(1)
	O(4)	46(1)	46(2)	12(1)	3(1)	4(1)	7(1)
	O(17)	44(1)	45(2)	18(1)	-6(1)	4(1)	4(1)
	C(10)	37(2)	37(2)	21(2)	0(1)	8(1)	-2(2)

5 Table 5. Hydrogen coordinates ($\times 10^4$) and isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for Compound 1.

		x	y	z	U(eq)
10	H(7)	11560(30)	-2840(70)	5320(30)	35(10)
	H(9)	12670(30)	-3980(70)	8120(30)	38(10)
	H(8)	12680(30)	-4860(70)	6660(30)	36(10)
	H(6)	10550(30)	350(80)	5580(30)	51(13)
15	H(15)	5770(30)	9730(70)	6900(30)	30(9)
	H(18)	9150(20)	8310(50)	9160(20)	12(7)
	H(17)	8620(30)	10600(60)	10030(30)	25(9)
	H(20A)	7470(30)	3650(70)	6460(30)	32(10)
	H(20B)	6130(30)	4320(80)	6280(30)	43(11)
20	H(21A)	8840(30)	6840(70)	5980(30)	40(11)
	H(21B)	8160(30)	9370(80)	5790(30)	42(11)
	H(22B)	5990(30)	9620(70)	5480(30)	31(9)
	H(22A)	5790(30)	7200(80)	4820(30)	48(12)
	H(24A)	3800(40)	12810(90)	7750(30)	57(13)
25	H(24B)	4210(30)	10410(70)	7420(30)	34(10)
	H(25A)	5370(30)	15130(60)	8770(20)	24(9)
	H(25B)	6240(30)	15040(70)	8150(30)	41(11)
	H(25C)	6690(30)	14100(80)	9230(30)	44(11)
	H(26A)	4600(30)	11790(60)	9320(20)	17(8)
30	H(26B)	5000(30)	9350(70)	9090(30)	28(9)
	H(1)	12000(30)	-1450(70)	9140(30)	40(11)
	H(2)	11050(40)	1550(80)	9460(40)	56(13)
	H(26C)	5950(30)	10770(80)	9820(30)	51(12)
	H(24C)	4720(40)	12850(100)	7170(40)	69(15)
35	H(22C)	5150(40)	7470(70)	5610(30)	42(11)
	H(21C)	7820(40)	7310(90)	5040(40)	62(14)
	H(20C)	6780(30)	3790(70)	5480(30)	48(12)
	H(12)	9030(40)	5290(90)	7280(40)	62(16)

5

[0264] Preparation of Amorphous Form from Form B**[0265]** A Buchi Spray drier was used in this method under the following conditions:

10 Inlet temperature set point : 130 °C
Outlet Temperature (start of run) 55 °C
Outlet temperature (end of run): 58 °C
Nitrogen pressure: 120psi
Aspirator: 100%
15 Pump: 40%
Filter pressure 11 mbar
Condenser Temperature: 10 °C
Run Time 15 min
Yield 86.5%
20 Dried in 25 °C vacuum over for 24 hours.
4g of Form B was dissolved in 86.4g of acetone and 9.6 g water under the above conditions. The run time was 15 min. The product was dried under vacuum at 25 °C for over 24 hrs to produce the Amorphous Form.

[0266] The XRPD spectrum of the Amorphous Form is shown in **FIG. 11**.25 **[0267]** The TGA trace for Amorphous Form is shown in **FIG. 12**.**[0269]** The DSC trace for Amorphous Form is shown in **FIG. 13**.**PK and solubility of different solid state forms of Compound 1**

30 **[0270]** Bioavailability of crystalline Form B, 85% amorphous Compound 1 and HPMCAS solid dispersion of Compound 1 were evaluated in rat, the results of which are provided in Table 4 below. These forms of the compound were dosed in an oral suspension with a vehicle containing 0.5% methyl cellulose/0.5% SLS/99% water. Bioavailability of various solid forms was evaluated as compared to a multicomponent IV solution of Compound
35 1. Bioavailability of crystalline polymorph B was 3-6%, compared to 61-95% for amorphous

5 material and 109-111% for solid dispersion. In FaSSIF, crystalline polymorph B has a measured solubility of 1.0 µg/ml, while the 85% amorphous material has a solubility of 67.4 µg/ml. The crystalline material showed 67-74% bioavailability when dosed as a PEG solution, indicating that absorption was solubility limited.

10

Table 4

Drug Form	Vehicle	Dose (mg/kg)	AUC (ug*hr/mL)		Tmax (h)		% F	
85% Amorphous	0.5% MC/0.5% SLS	50	135.5	27.6	6.0	0.0	95.0	20.0
85% Amorphous	0.5% MC/0.5% SLS	200	371.9	46.1	6.0	0.0	61.0	7.0
Crystalline	0.5% MC/0.5% SLS	50	8.0	1.2	4.0	0.0	5.5	0.8
Crystalline	0.5% MC/0.5% SLS	200	16.9	3.0	4.7	1.2	3.1	0.3
Crystalline	PEG	50	135.1	43.0	5.5	1.0	74.0	23.0
Crystalline	PEG	200	431.5	101.1	14.5	11.0	67.0	16.0
Solid Dispersion	0.5% MC/0.5% SLS	25	90.1	8.1	6.0	0.0	111.0	10.0
Solid Dispersion	0.5% MC/0.5% SLS	100	260.8	28.4	6.0	0.0	109.0	12.0

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CLAIMS:

1. A solid dispersion comprising amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, and a polymer.
2. A solid dispersion comprising amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, wherein the solid dispersion further comprises a surfactant, polymer, or inert pharmaceutically acceptable substance.
3. A solid dispersion comprising amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, and a polymer,
wherein the solid dispersion comprises less than 40% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
4. The solid dispersion of claim 3, wherein the solid dispersion comprises less than 30% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
5. The solid dispersion of claim 3, wherein the solid dispersion comprises less than 25% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
6. The solid dispersion of claim 3, wherein the solid dispersion comprises less than 20% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
7. The solid dispersion of claim 3, wherein the solid dispersion comprises less than 15% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
8. The solid dispersion of claim 3, wherein the solid dispersion comprises less than 10% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

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9. The solid dispersion of claim 3, wherein the solid dispersion comprises less than 5% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
10. The solid dispersion of claim 3, wherein the solid dispersion comprises less than 2% of crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
11. The solid dispersion of any one of claims 1-10, wherein the polymer is one or more than one water-soluble polymer or partially water-soluble polymer.
12. The solid dispersion of any one of claims 1-11, wherein the polymer is hydroxypropylmethylcellulose (HPMC), hydroxypropylcellulose (HPC), ethylcellulose, hydroxypropylmethylcellulose acetate succinate (HPMCAS), polyvinylpyrrolidones (PVP), polyethylene glycols (PEG), polyvinyl alcohols (PVA), polymethacrylate, β -cyclodextrin, or vinylpyrrolidone/vinyl acetate copolymer (PVP/VA).
13. The solid dispersion of any one of claims 1-12, wherein the polymer is hydroxypropylmethylcellulose (HPMC).
14. The solid dispersion of any one of claims 1-12, wherein the polymer is hydroxypropylmethylcellulose acetate succinate (HPMCAS).
15. The solid dispersion of any one of claims 1-12, wherein the polymer is vinylpyrrolidone/vinyl acetate copolymer (PVP/VA).
16. The solid dispersion of any one of claims 1-15, wherein the polymer is present in an amount of from 10% by weight to 80% by weight.
17. The solid dispersion of claim 16, wherein the polymer is present in an amount of from 10% by weight to less than 70% by weight.
18. The solid dispersion of claim 17, wherein the polymer is present in an amount of 50% by weight.

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19. The solid dispersion of claim 17, wherein the polymer is present in an amount of 49.5% by weight.
20. The solid dispersion of any one of claims 1-19, wherein the N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an amount of from 10% by weight to 80% by weight.
21. The solid dispersion of claim 20, wherein the N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an amount of from 10% by weight to less than 70% by weight.
22. The solid dispersion of claim 21, wherein the N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an amount of 50% by weight.
23. The solid dispersion of any one of claims 1-22, further comprising a surfactant.
24. The solid dispersion of claim 23, wherein the surfactant is sodium lauryl sulfate.
25. The solid dispersion of claim 23 or 24, wherein the surfactant is present in an amount from 0.1 to 5% by weight.
26. The solid dispersion of any one of claims 23-25, wherein the surfactant is present in 0.5% by weight.
27. The solid dispersion according to any one of claims 1-26, wherein the solid dispersion is obtained by spray drying.
28. A pharmaceutical composition comprising amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide as a solid dispersion and a pharmaceutically acceptable carrier, adjuvant or vehicle.
29. The pharmaceutical composition according to claim 28, wherein the composition further comprises a polymer.

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30. The pharmaceutical composition of claim 29, wherein the polymer is one or more than one water-soluble polymer or partially water-soluble polymer.

31. The pharmaceutical composition of claim 29 or 30, wherein the polymer is hydroxypropylmethylcellulose (HPMC), hydroxypropylcellulose (HPC), ethylcellulose,
5 hydroxypropylmethylcellulose acetate succinate (HPMCAS), polyvinylpyrrolidones (PVP), polyethylene glycols (PEG), polyvinyl alcohols (PVA), polymethacrylate, β -cyclodextrin, or vinylpyrrolidone/vinyl acetate copolymer (PVP/VA).

32. The pharmaceutical composition of any one of claims 29-31, wherein the polymer is HPMC or HPMCAS.

10 33. The pharmaceutical composition of any one of claims 29-31, wherein the polymer is PVP/VA.

34. A pharmaceutical composition comprising:

i. a solid dispersion comprising amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, wherein said N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an
15 amount from 30 to 75% by weight of the pharmaceutical composition;

ii. one or more polymers selected from the group consisting of HPMC and HPMCAS, wherein said polymer is present in an amount from 30 to 75% by weight of the pharmaceutical composition;

20 iii. a surfactant, wherein said surfactant is present in an amount from 0.25 to 1% by weight of the pharmaceutical composition; and

iv. a pharmaceutically acceptable carrier, adjuvant or vehicle.

35. The pharmaceutical composition of claim 34, wherein the polymer is HPMCAS.

25 36. The pharmaceutical composition of claim 34, wherein the polymer is HPMC.

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37. The pharmaceutical composition of any one of claims 34-36, wherein the surfactant is sodium laurel sulfate.

38. The pharmaceutical composition of any one of claims 34-37, wherein:

5 i. said N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is present in an amount of 50% by weight of the pharmaceutical composition,

ii. said polymer is HPMCAS and is present in an amount of 49.5% by weight of the pharmaceutical composition, and

10 iii. a said surfactant is sodium laurel sulfate and is present in an amount of 0.5 % by weight of the pharmaceutical composition.

39. A process for preparing an amorphous form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide comprising spray-drying N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide to provide an amorphous form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

40. The process of claim 39, comprising combining N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and a solvent comprising MEK or acetone to form a mixture and then spray-drying the mixture to obtain the amorphous form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

41. The process of claim 40, wherein the mixture is a solution N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and a solvent comprising MEK or acetone.

42. The process of claim 40 or 41, wherein the solvent comprises a mixture of solvents.

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43. The process of any one of claims 40-42, wherein the solvent comprises a mixture of acetone and water or a mixture of MEK and water.
44. The process of any one of claims 40-43, wherein the water in the solvent mixture is present at 10% by weight of the solvent mixture.
- 5 45. The process of any one of claims 40-44, comprising
- a) forming a mixture comprising N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, a polymer, and a solvent; and
- b) spray-drying the mixture to form a solid dispersion comprising N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
- 10 46. The process of claim 45, wherein the mixture comprises a solution of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, the polymer, and the solvent.
47. The process of claim 46, wherein the polymer is HPMC or HPMCAS.
48. The process of claim 46, wherein the polymer is PVP/VA.
- 15 49. The process of any one of claims 45-48, wherein the polymer is present in an amount of from 30% to 70% by weight in the solid dispersion.
50. The process of any one of claims 45-49, wherein the mixture further comprises a surfactant.
51. The process according to claim 50, wherein the surfactant is sodium lauryl
- 20 sulfate (SLS).
52. The process according to any one of claims 45-51, wherein the solvent comprises acetone.
53. The process of any one of claims 45-52, wherein the solvent comprises a mixture of acetone and water.

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54. The process of any one of claims 45-53, wherein the solvent comprises up to 20% by weight water.

55. The process of any one of claims 45-53, wherein the solvent comprises from 70% to 100% by weight acetone.

5 56. A solid dispersion prepared according to the process of any one of claims 45-55.

57. A crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, characterized by a peak at 5.0 and a peak
10 at 15.6 degrees two theta in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.

58. The crystal form of claim 57, wherein the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 9.9 degrees two theta in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.

15 59. The crystal form of claim 57 or 58, wherein the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 14.9 degrees two theta in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.

60. The crystal form of any one of claims 57-59, wherein the crystal form of
20 N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 18.1 degrees two theta in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.

61. The crystal form of any one of claims 57-60, wherein the crystal form of
25 N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by a peak at 28.0 degrees two theta in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.

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62. The crystal form of any one of claims 57-61, wherein the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide further characterized by a peak at 30.9 degrees two theta in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.

5 63. The crystal form of any one of claims 57-62, wherein said crystal form is characterized by an X-ray powder diffraction pattern obtained using Cu K alpha radiation as shown in FIGURE 4.

64. A pharmaceutical composition comprising the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide according to
10 any one of claims 57-63, and a pharmaceutically acceptable adjuvant or carrier.

65. A process for preparing a crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide according to any one of claims 57-63, wherein said process comprises the step of heating N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide to 250 °C and
15 cooling to room temperature.

66. Solid amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.

67. A composition comprising solid amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and less than 15% crystalline N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide.
20

68. A pharmaceutical composition comprising solid amorphous N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide and a pharmaceutically acceptable carrier, adjuvant or vehicle.

69. A crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, characterized by one or more peaks at 6.2, 7.6, 12.3, and 18.0 degrees two theta in an X-ray powder diffraction pattern obtained using Cu K alpha radiation.
25

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70. The crystal form of claim 69, wherein the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by the following peak 8.40 degrees two theta.

71. The crystal form of claim 69 or 70, wherein the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by the following peak 14.8 degrees two theta.

72. The crystal form of any one of claims 69-71, wherein the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide is further characterized by the following peak 21.1 degrees two theta.

73. The crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide according to any one of claims 64-67, characterized by an X-ray powder diffraction pattern obtained using Cu K alpha radiation substantially similar to FIGURE 7.

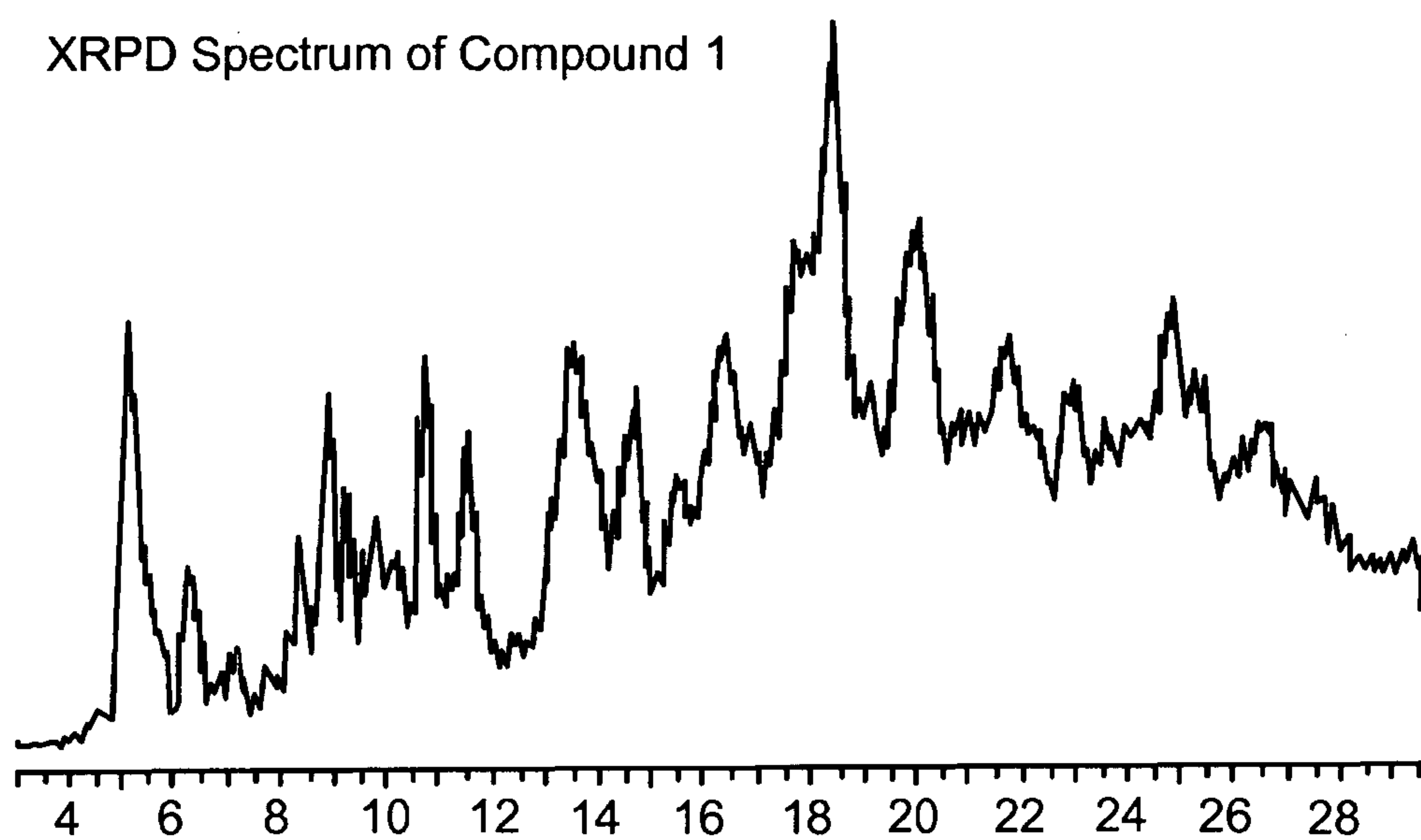
74. A pharmaceutical composition comprising the crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide according to any one of claims 69-73, and a pharmaceutically acceptable adjuvant or carrier.

75. A crystal form of N-[2,4-bis(1,1-dimethylethyl)-5-hydroxyphenyl]-1,4-dihydro-4-oxoquinoline-3-carboxamide, having a monoclinic crystal system, a $P2_1$ space grouping, and the following unit cell dimensions:

a = 11.8011(7) Å	$\alpha = 90^\circ$
b = 5.9819(3) Å	$\beta = 105.110(4)^\circ$
c = 14.7974(8) Å	$\gamma = 90^\circ$.

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XRPD Spectrum of Compound 1



2-Theta - Scale

FIG. 1

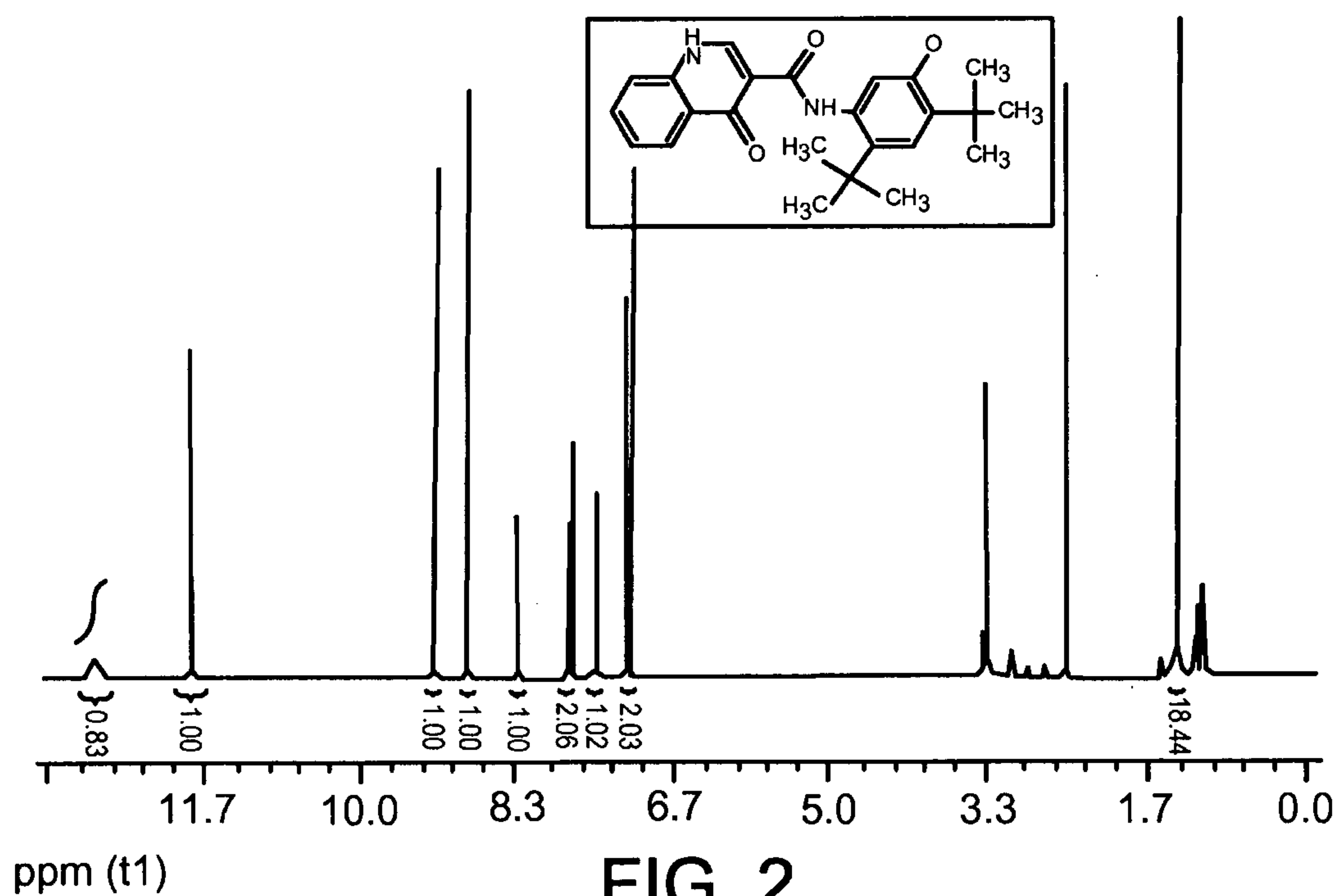
¹H NMR Spectrum of Compound 1

FIG. 2

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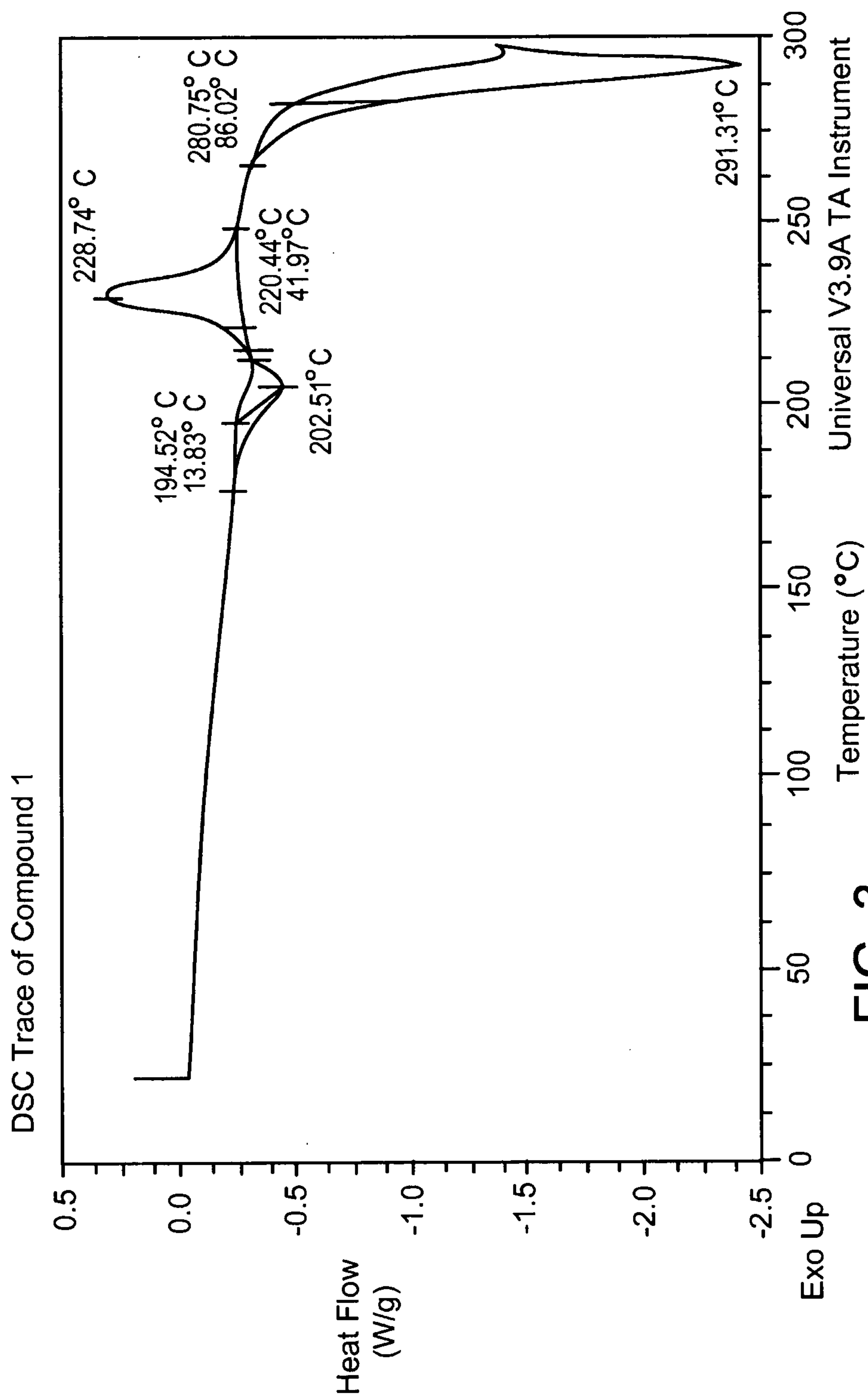


FIG. 3

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Powder X-Ray Diffraction pattern of Form A:

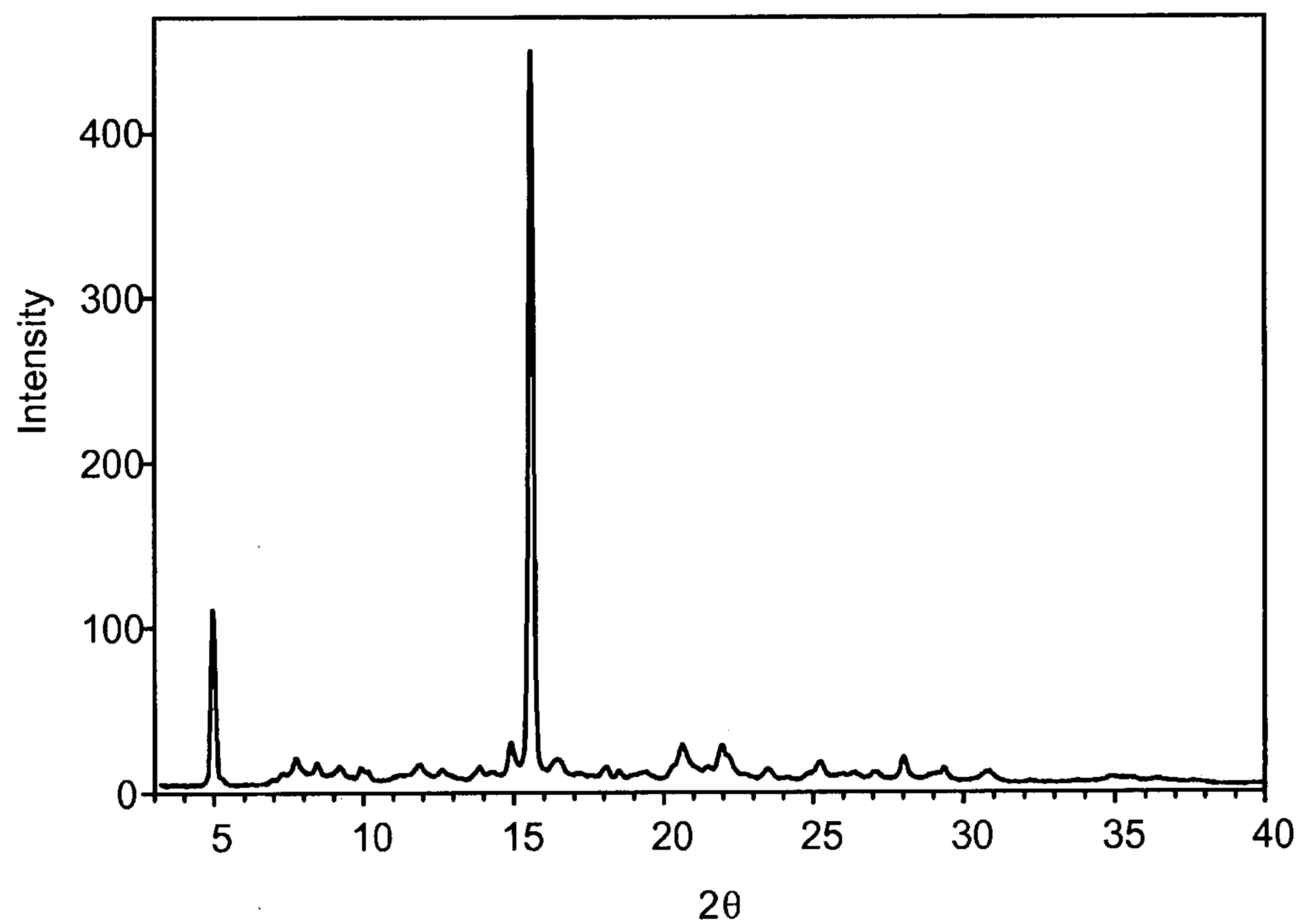


FIG. 4

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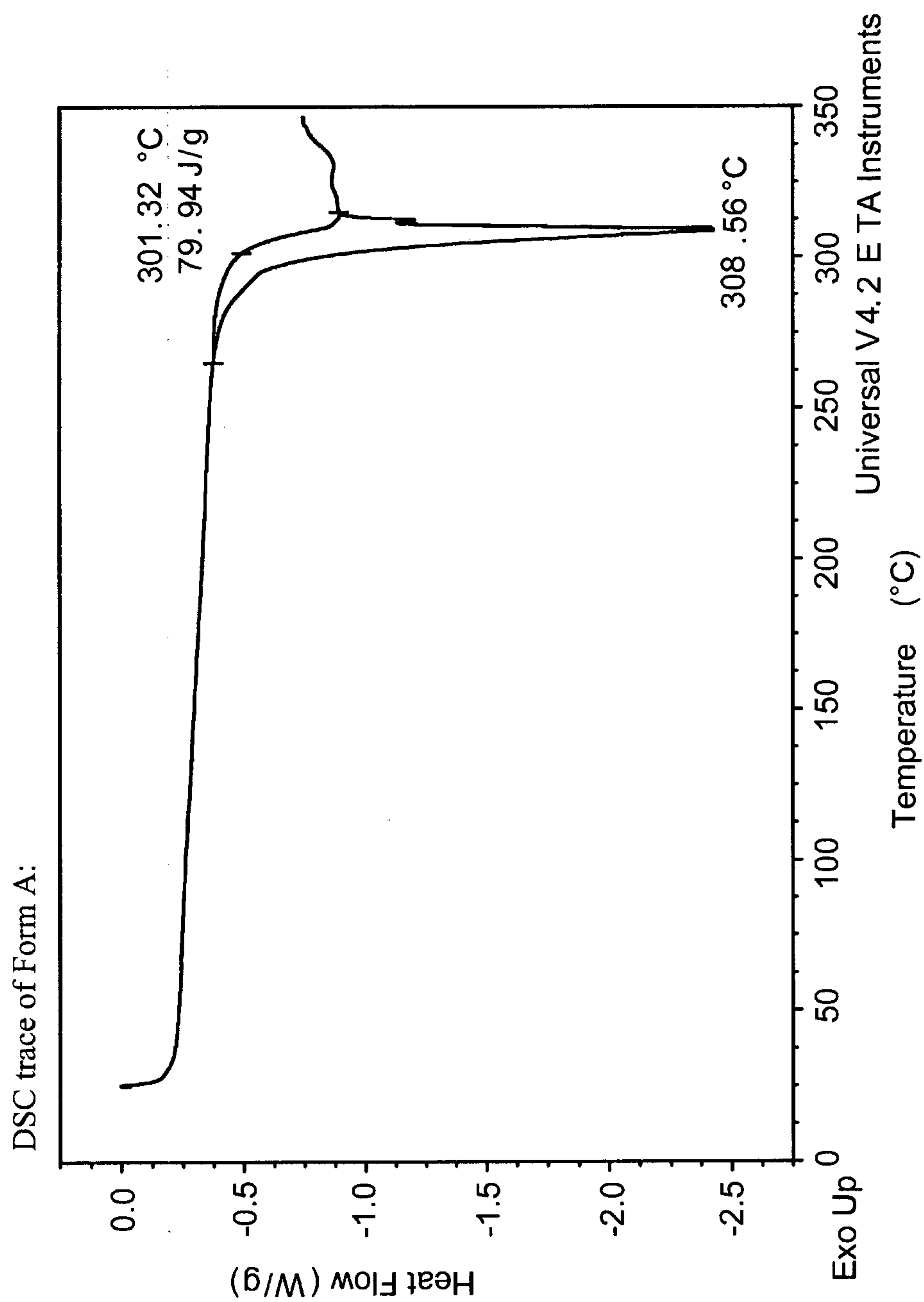


FIG. 5

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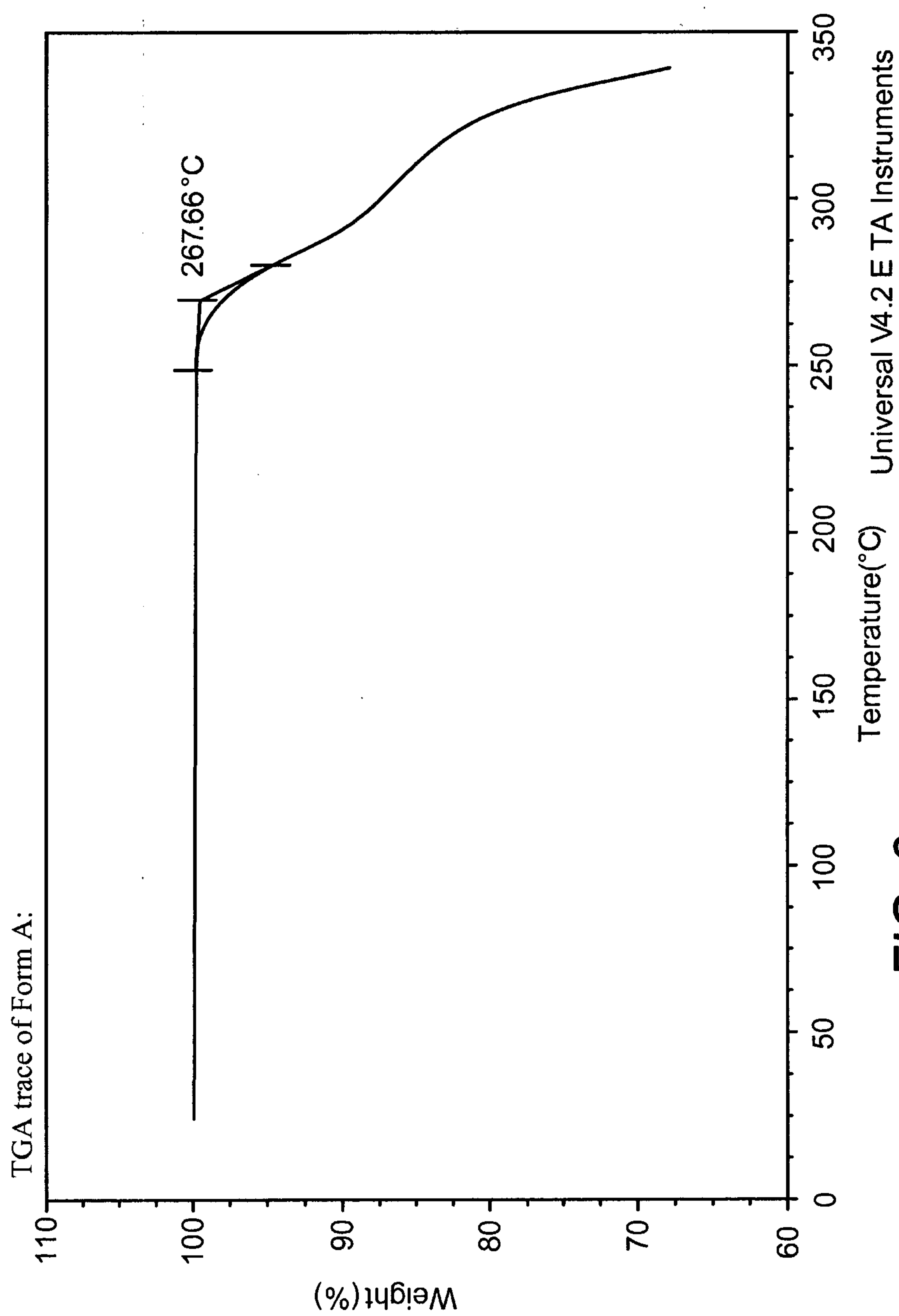
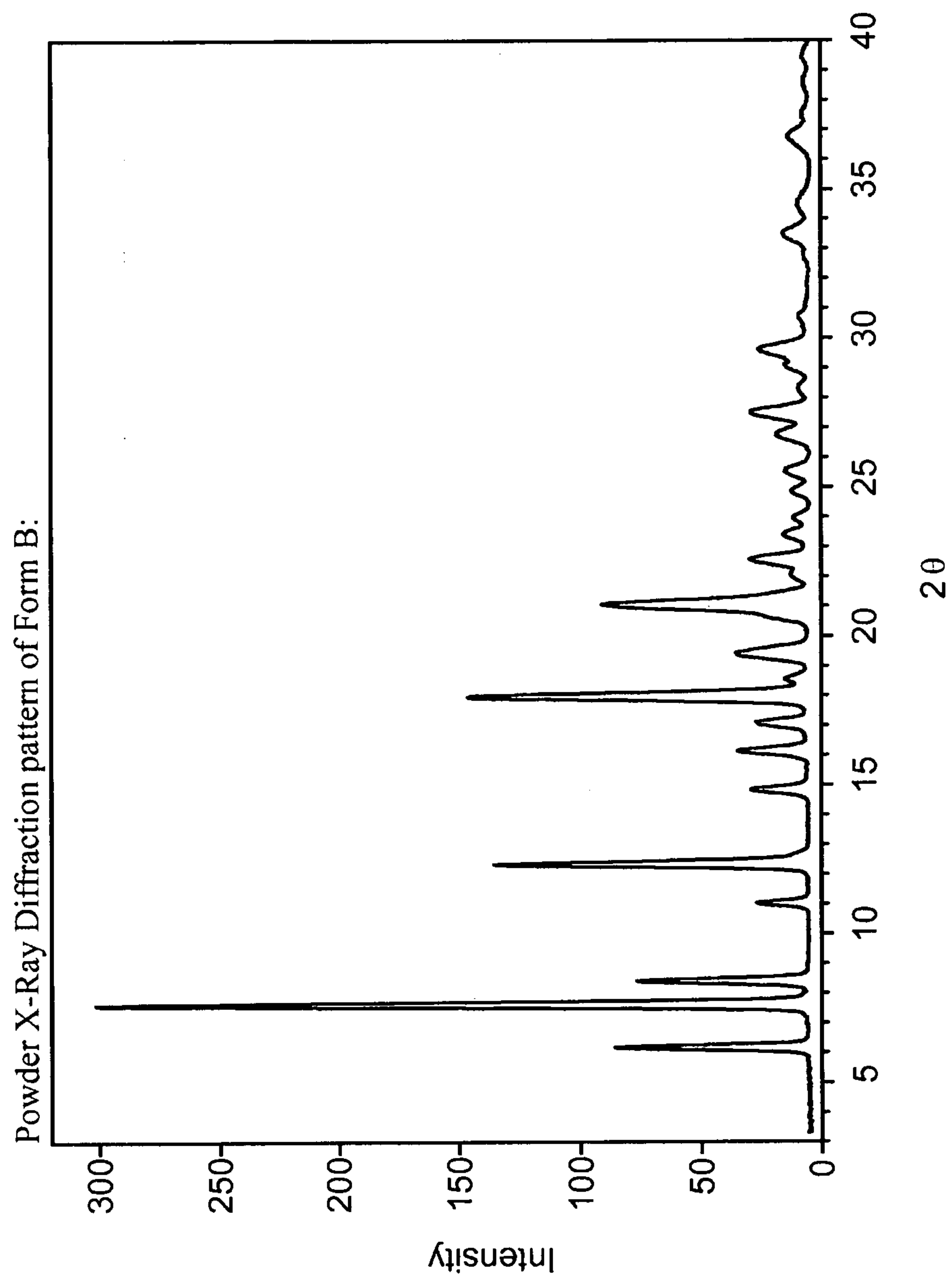


FIG. 6

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2θ
FIG. 7

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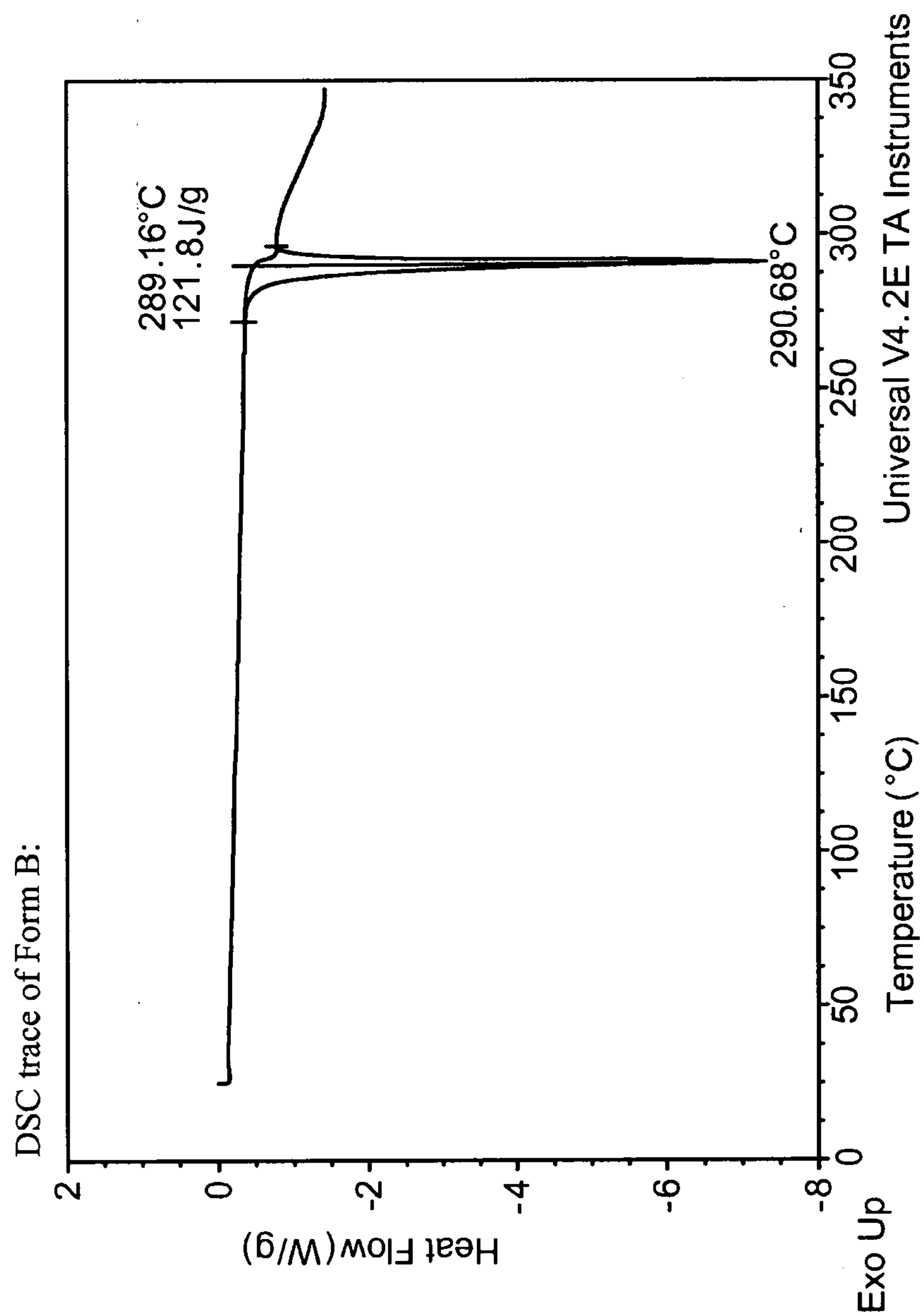
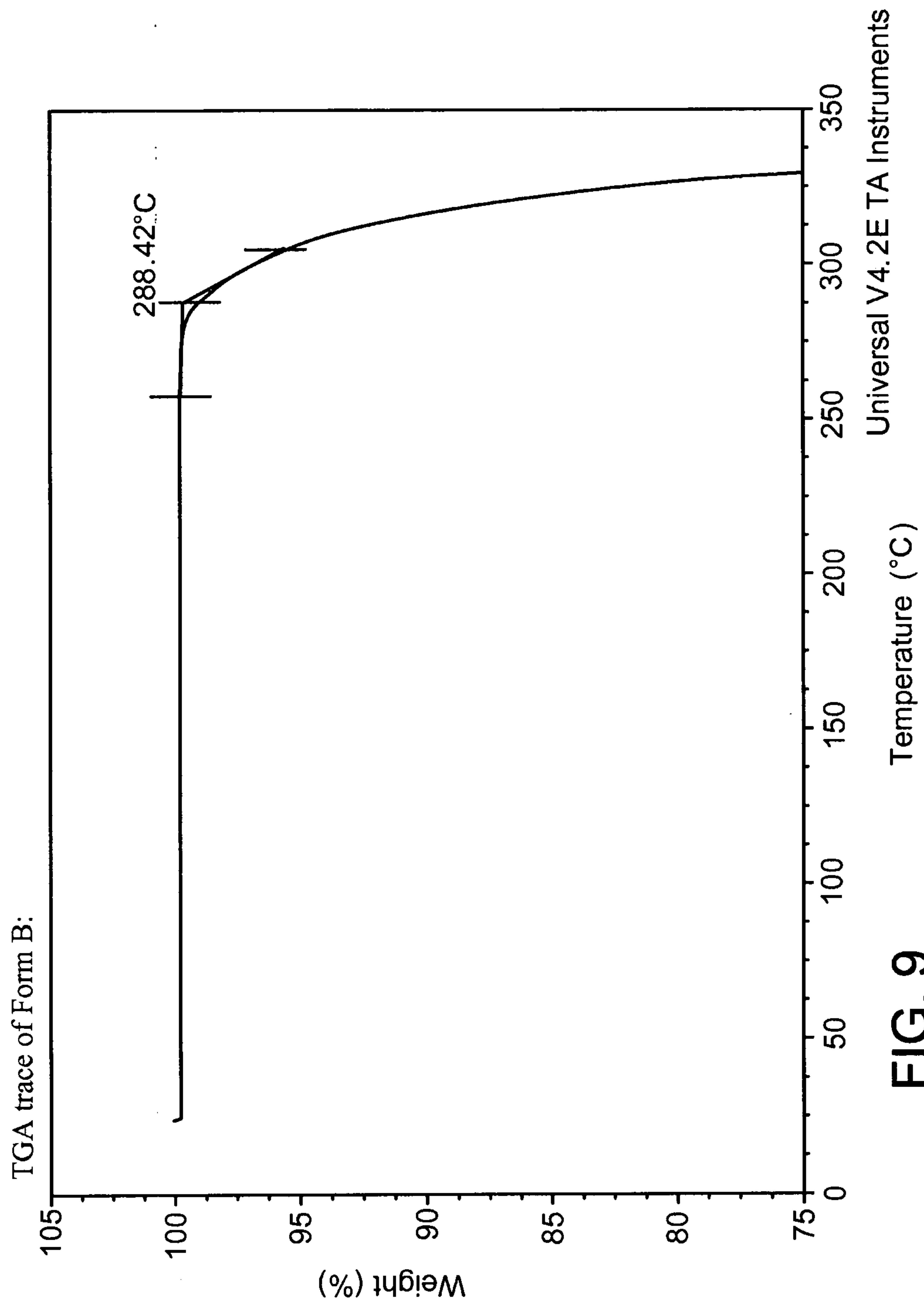


FIG. 8

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**FIG. 9**

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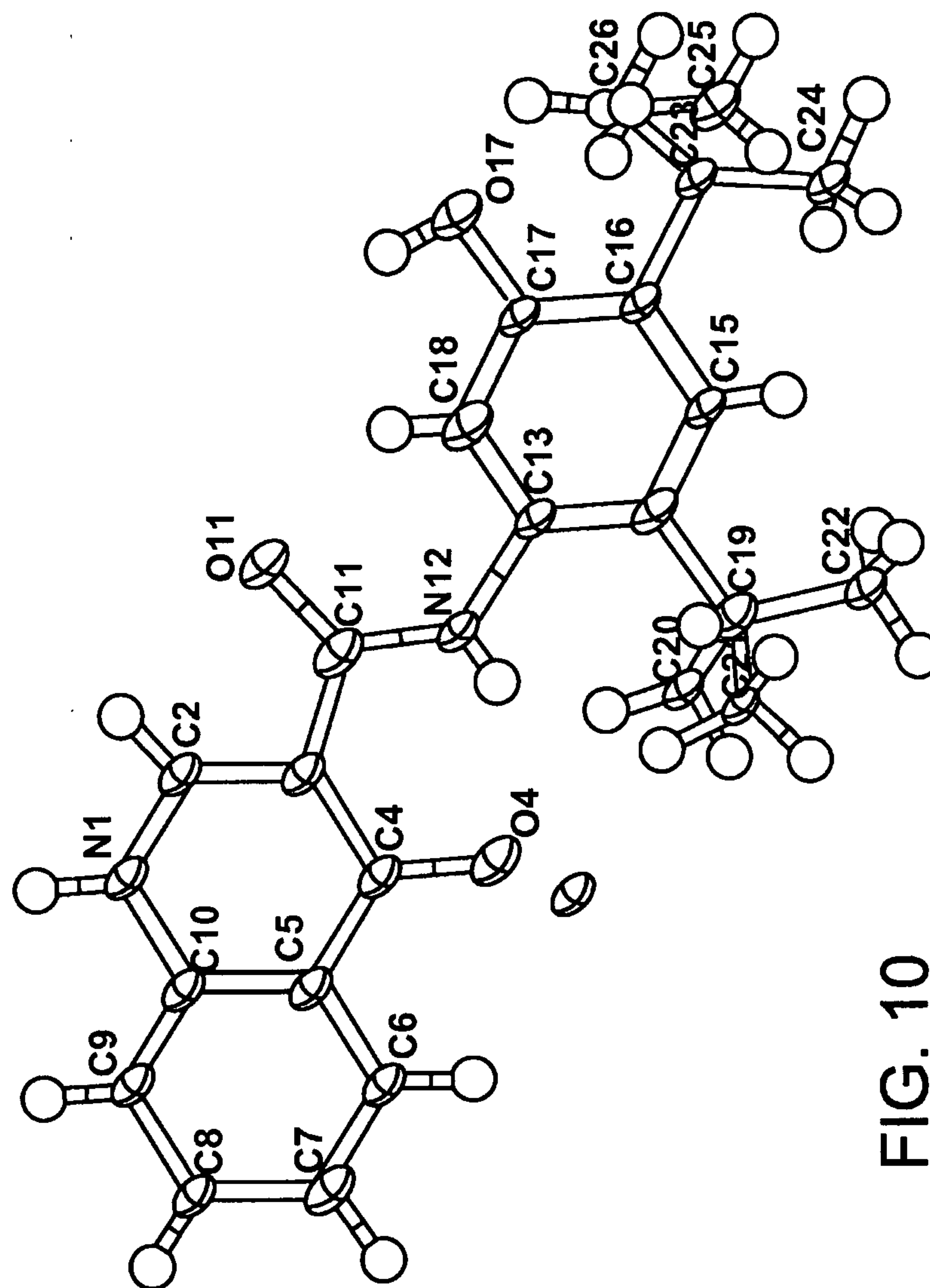


FIG. 10

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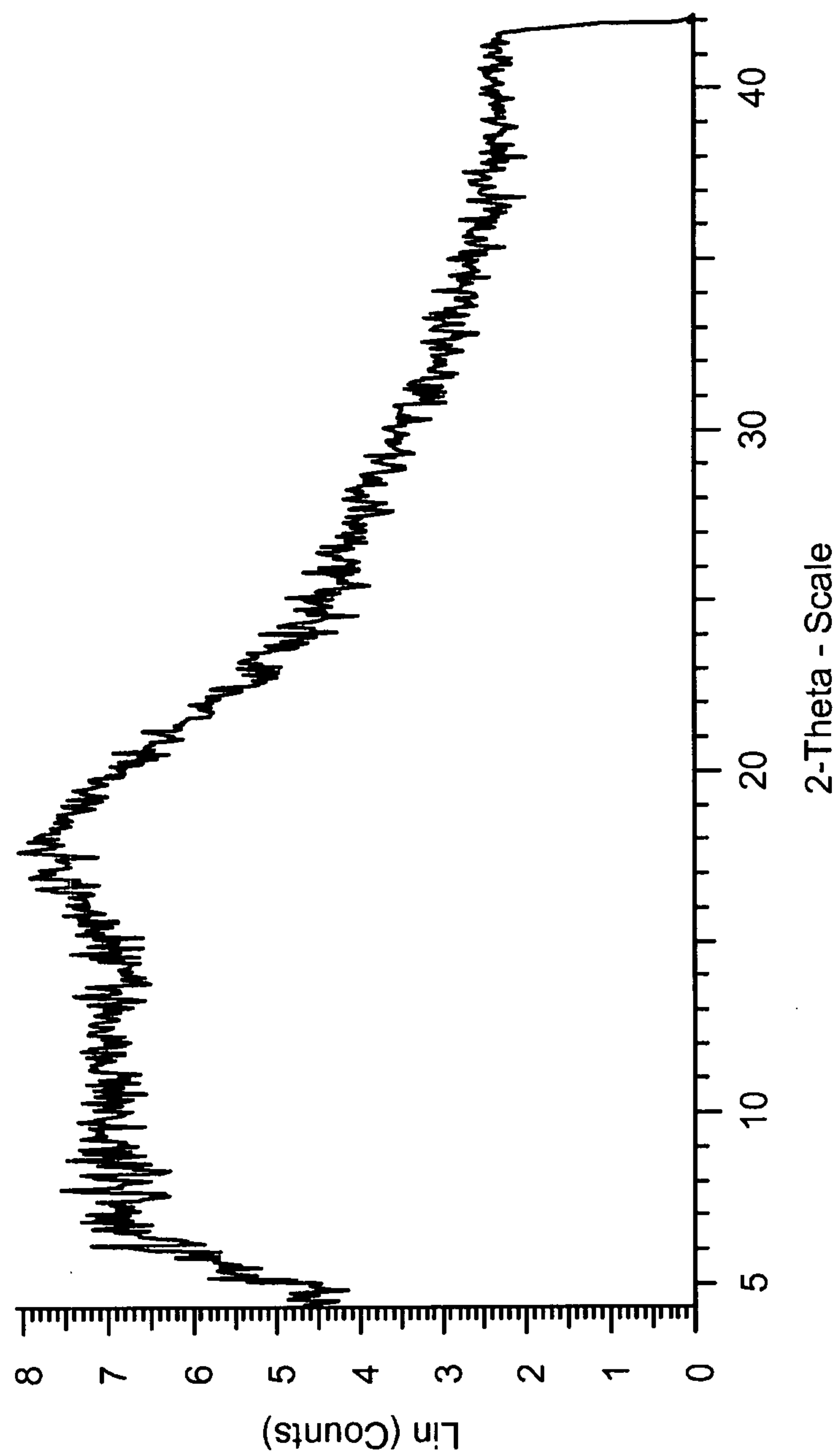
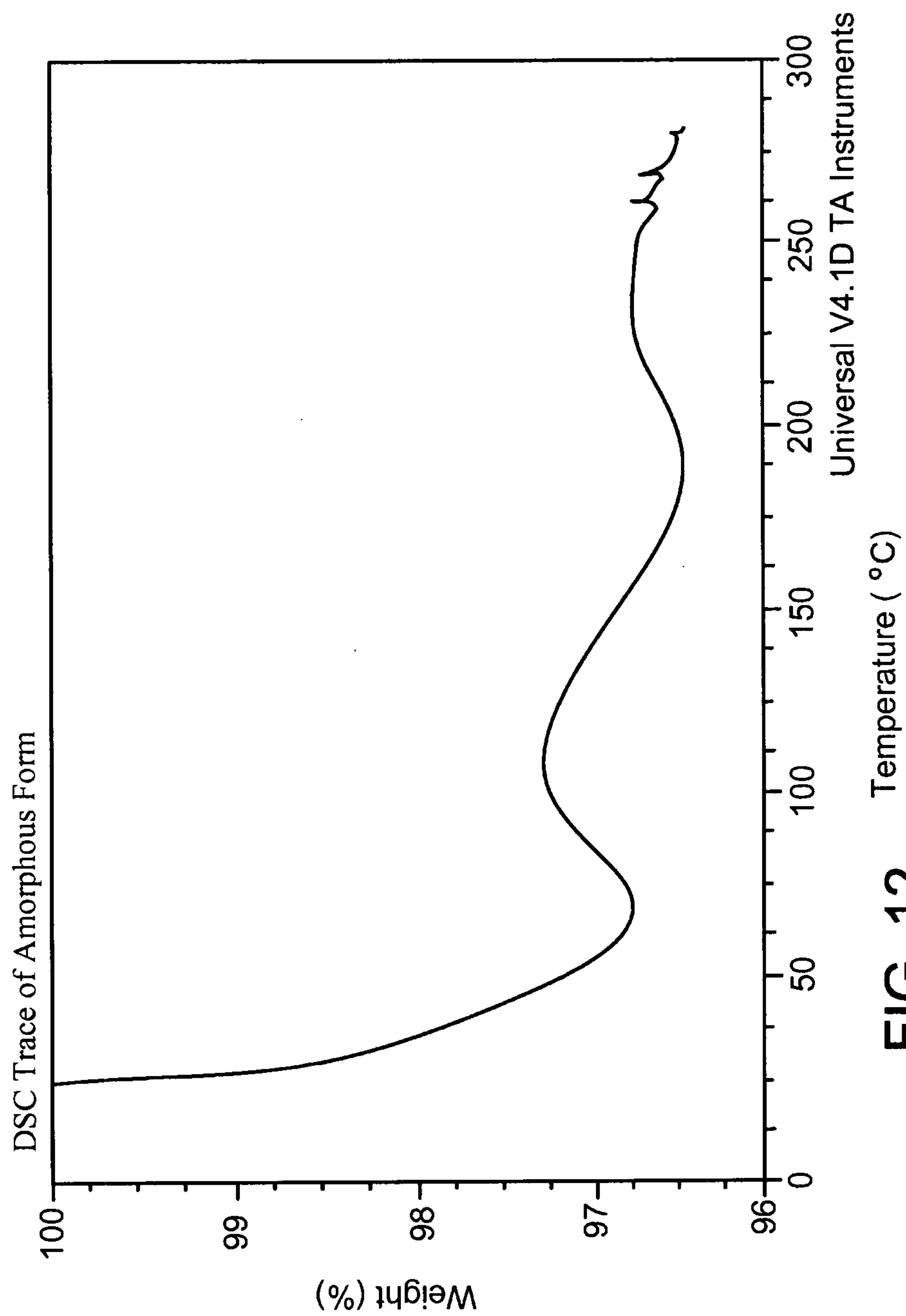


FIG. 11

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