AmoyDx® *RET* Gene Fusions Detection Kit

For qualitative detection of 9 *RET* gene fusions

Instruction for Use

REF 8.01.23301X012H	12 tests	For Stratagene Mx3000P™, ABI 7500, LightCycler480 II, Bio-Rad CFX96, Rotor-Gene Q/6000 (72 wells)

Amoy Diagnostics Co., Ltd.
39 Dingshan Road, Haicang District,
Xiamen 361027, P. R. China
Tel: +86 592 6806835
Fax: +86 592 6806839
E-mail: sales@amoydx.com
Website: http://www.amoydx.com

EC REP **Wellkang Ltd**
Suite B, 29 Harley Street,
London W1G 9QR United Kingdom

Version: B2.1
December 2017

Background

RET proto-oncogene encodes a receptor tyrosine kinase for members of the glial cell line-derived neurotrophic factor family of extracellular signaling molecules. *RET* gene fusions define a unique molecular subset of non–small-cell lung cancer (NSCLC). The *RET* fusion partners include *KIF5B, CCDC6, NCOA4* etc. These fusions lead to constitutive kinase activity and activation of downstream pathways, such as RAS/ERK、PI3K/AKT and MAPK/JNK etc., leading to carcinogenesis. It has been reported that the presence of the *RET* rearrangement is correlated with the efficacy of TKI therapy. Based on analysis of tumor messenger RNA, *RET* gene fusions can be detected by real-time PCR method.

Intended Use

The AmoyDx® *RET* Gene Fusions Detection Kit is a real-time PCR test intended for qualitative detection of 9 *RET* gene fusions in human total RNA extracted from NSCLC formalin-fixed paraffin-embedded (FFPE) tissue samples.

The kit is for *in vitro* diagnostic use, and intended to be used by trained professionals in a laboratory environment.

Principles of the Procedure

The kit is based on two major processes: 1) **Reverse Transcription**: extracted RNA from FFPE tumor tissue is employed in this step, reverse transcription of target RNA enables complementary DNA (cDNA) synthesis with the action of reverse transcriptase and specific primers. 2) **PCR Amplification**: the specific primers are designed for amplification of *RET* variant cDNA, and mutant amplicon is detected by fluorescent probes labeled with FAM, while reference gene amplicon is detected by fluorescent probe labeled with HEX.

The kit is composed of *RET* RT Reaction Mix, four *RET* reaction mixes, sufficient positive control and enzyme.

1) The **L-RET RT Reaction Mix** contains primers specific for reverse transcription of both *RET* RNA and reference gene RNA into complementary DNA (cDNA).
2) The **L-RET Reaction Mixes** ①~④ contains primers and FAM-labeled probes specific for *RET* gene fusions. The **L-RET Reaction Mix** ④ also contains primers and HEX–labeled probe for detection of reference gene to reveal the presence of PCR inhibitors or RNA integrality that may lead to false negative results.
3) The **L-RET Positive Control** contains recombinant gene with *RET* gene fusions.
4) The **L-RET Enzyme Mix** contains the Taq DNA polymerase for PCR amplification and uracil-N-glycosylase which works at room temperature to prevent PCR amplicon carryover contamination.

Kit Contents

The kit contains the following materials:

Table 1 Kit Contents

Tube No.	Content	Main Ingredients	Quantity	Fluorescent signal
①	L-RET Reaction Mix ①	Primers, Probes, Mg^{2+}, dNTPs,	550 µL/tube ×1	FAM
②	L-RET Reaction Mix ②	Primers, Probes, Mg^{2+}, dNTPs,	550 µL/tube ×1	FAM
③	L-RET Reaction Mix ③	Primers, Probes, Mg^{2+}, dNTPs,	550 µL/tube ×1	FAM
④	L-RET Reaction Mix ④	Primers, Probes, Mg^{2+}, dNTPs,	550 µL/tube ×1	FAM, HEX/VIC
⑤	L-RET RT Reaction Mix	Primers, Mg^{2+}, dNTPs	300 µL/tube ×1	/
/	L-RET Reverse Transcriptase	Reverse Transcriptase	10 µL/tube ×1	/
/	L-RET Enzyme Mix	Taq DNA Polymerase, Uracil-N-Glycosylase	30 µL/tube ×1	/
/	L-RET Positive Control	Plasmid DNA	150 µL/tube ×1	/

Storage and Stability

The kit requires shipment on frozen ice packs. All contents of the kit should be stored immediately upon receipt at -20±5℃ and protected from light.

The shelf-life of the kit is eight months. The recommend maximum freeze-thaw cycle is five cycles.

Additional Reagents and Equipment Required but Not Supplied

1) Compatible PCR instruments
   Stratagene Mx3000P™, ABI 7500, LightCycler480 II, Bio-Rad CFX96, Rotor-Gene Q/6000 (72 wells).
2) RNA extraction kit: we recommend use of AmoyDx RNA extraction kit (AmoyDx® FFPE RNA Kit, Cat No.: 8.02.24101X036G, for paraffin embedded specimens).
3) Spectrophotometer for measuring RNA concentration.
4) Mini centrifuge with rotor for centrifuge tubes.
5) Mini centrifuge with rotor for PCR tubes.
6) Nuclease-free centrifuge tubes.
7) Nuclease-free PCR tubes and caps.
8) Adjustable pipettors and filtered pipette tips for handling RNA.
9) Tube racks.
10) Disposable powder-free gloves.
11) Sterile, nuclease-free water.

Precautions and Handling Requirements

For *in vitro* diagnostic use.

Precautions

- Please read the instruction carefully and become familiar with all components of the kit prior to use, and strictly follow the instruction during operation.
- Please check the compatible real-time PCR instruments prior to use.
- DO NOT use the kit or any kit component after their expiry date.
- DO NOT use any other reagents from different lots in the tests.
- DO NOT use any other reagent in the other test kits.

Safety Information

- Handle all specimens and components of the kit as potentially infectious material using safe laboratory procedures.
- Only trained professionals can use this kit. Please wear suitable lab coat and disposable gloves while handling the reagents.
- Avoid skin, eyes and mucous membranes contact with the chemicals. In case of contact, flush with water immediately.
- DO NOT pipet by mouth.

Decontamination and Disposal

- The kit contains positive control; strictly distinguish the positive control from other reagents to avoid contamination which may cause false positive.
- PCR amplification is extremely sensitive to cross-contamination. The flow of tubes, racks, pipets and other materials used should be from pre-amplification to post-amplification, and never backwards.
- Gloves should be worn and changed frequently when handling samples and reagents to prevent contamination.
- Using separate, dedicated pipettes and filtered pipette tips when handling samples and reagents to prevent exogenous nucleic acid contamination to the reagents.

- Please pack the post-amplification tubes with two disposable gloves and discard properly. DO NOT open the post- amplification PCR tubes.
- All disposable materials are for one time use. DO NOT reuse.
- The unused reagents, used kit, and waste must be disposed of properly.

Cleaning

- After the experiment, wipe down the work area, spray down the pipettes and equipment with 75% ethanol or 10% hypochlorous acid solution.

Instrument Setup

- Setup the reaction volume as 40 μL.
- For Stratagene Mx3000P™, if there's low net fluorescence signal (dR) but high background signals (R), please reduce the signal gain setting of instrument properly.
- For ABI instrument, please set up as follows: Reporter Dye: FAM, VIC; Quencher Dye: TAMRA; Passive Reference: NONE.
- For LightCycler480 II, if there is fluorescence crossover on instrument, fluorescence calibration is also required. To run the assays on a LightCycler machine, please use the Roche 480 adaptor, available from BIOplastics, Cat No. B79480.
- Refer to the real-time PCR instrument operator's manual for detailed instructions.
- We recommend that all PCR instruments in use should be conducted fluorescence calibration once a year.

Assay Procedure

1. RNA Extraction

The specimen material must be extracted RNA from NSCLC FFPE tissue samples. RNA extraction kit is not included in the kit. Before RNA extraction, it's essential to use standard pathology methodology to ensure tumor sample quality and make sure that there is at least 30% tumor cells in the FFPE tissue samples. Carry out the RNA extraction according to the instructions of RNA extraction kit.

The OD value of extracted RNA should be measured using the spectrophotometer after extraction. OD_{260}/OD_{280} value should be between 1.9~2.1 and total RNA concentration should be between 50~800 ng/μL.

Note:

- *The FFPE tissue should be handled and stored properly, and the storage time should preferably be less than 2 years.*
- *The extracted RNA should be used immediately, if not, it should be stored at --20±5℃ for no more than one week.*

2. Reverse Transcription

1) Take **L-RET RT Reaction Mix** and **L-RET Reverse Transcriptase** as need out of the kit from the freezer, and other reagents remained in freezer at -20±5℃.
2) Thaw **L-RET RT Reaction Mix** at room temperature. When the reagents completely thawed, invert each tube for 10 times and briefly centrifuge to collect all liquid at the bottom of the tube.
3) Briefly centrifuge **L-RET Reverse Transcriptase** prior to use.
4) Prepare a sterile nuclease-free PCR tube for each sample: transfer 18.5 μL **L-RET RT Reaction Mix** and 0.5 μL **L-RET Reverse Transcriptase** to the tube.
5) Add 6 μL sample RNA into the appropriate centrifuge tube. Mix well by gently pipetting up and down more than 10 times, and then centrifuge briefly. Thoroughly mix the reagents by gently pipetting up and down more than 10 times, and then centrifuge briefly.
6) Incubate the tubes at 42℃ for one hour.
7) Heat the tubes at 95℃ for 5 minutes, then transfer them to ice. The resulting cDNA solutions are used for subsequent PCR amplification.

Note: *sample cDNA should be used immediately, if not, it should be stored at -20±5℃ for no more than one week after reverse transcription.*

3. PCR amplification

1) Take **L-RET Reaction Mixes** ①~④, **L-RET Positive Control** and **L-RET Enzyme Mix** out of the kit from the freezer.
2) Thaw **L-RET Reaction Mix** ①～④ and **L-RET Positive Control** at room temperature. When the reagents completely thawed, invert the tube for 10 times and briefly centrifuge to collect all liquid at the bottom of the tube.
3) Briefly centrifuge **L-RET Enzyme Mix** prior to use.
4) Prepare sufficient L-RET Master Mix 1~4 containing L-RET Enzyme Mix and each L-RET Reaction Mix (L-RET Reaction Mix ①~④, respectively) in separate sterile centrifuge tube according to the ratio in Table 2. Thoroughly mix each L-RET Master Mix by gently pipetting up and down more than 10 times.

Table 2 L-*RET* Master Mix

Content	Volume per test
L-RET Enzyme Mix	0.3 μL
L-RET Reaction Mix	35 μL
Total	**35.3 μL**

Note:

- *Every PCR run must contain one PC (Positive control) and one NTC (No template control).*
- *Do not vortex enzyme mix or any mixture with enzyme mix.*
- *The prepared mixtures should be used immediately, avoid prolonged storage.*
- *Due to the viscosity of the enzyme mix, pipet slowly to ensure all mix is completely dispensed from the tip.*
- *Pipet enzyme mix by placing the pipet tip just under the liquid surface to avoid the tip being coated in excess enzyme.*

5) Take out the sample cDNA and nuclease-free water for NTC (No template control).
6) Prepare 4 PCR tubes for NTC: Dispense 35 μL of L-RET Master Mix 1~4 to each PCR tube respectively. Then add 5 μL of nuclease-free water to each PCR tube, and cap the PCR tubes.
7) Prepare 4 PCR tubes for each sample: Dispense 35 μL of L-RET Master Mix 1~4 to each PCR tube respectively. Then add 5 μL of sample cDNA to each PCR tube, and cap the PCR tubes.
8) Prepare 4 PCR tubes for PC: Dispense 35 μL of L-RET Master Mix 1~4 to each PCR tube respectively. Then add 5 μL of **L-RET Positive Control** to each PCR tube, and cap the PCR tubes
9) Briefly centrifuge the PCR tubes to collect all liquid at the bottom of each PCR tube.
10) Place the PCR tubes into the appropriate positions of the real-time PCR instrument. A recommended plate layout is shown in Table 3.

Table 3 Recommended Plate Layout

Tube No.	1	2	3	4	5	6	7
①	Sample 1	Sample 3	Sample 5	Sample 7	Sample 9	Sample 11	NTC
②	Sample 1	Sample 3	Sample 5	Sample 7	Sample 9	Sample 11	NTC
③	Sample 1	Sample 3	Sample 5	Sample 7	Sample 9	Sample 11	NTC
④	Sample 1	Sample 3	Sample 5	Sample 7	Sample 9	Sample 11	NTC
①	Sample 2	Sample 4	Sample 6	Sample 8	Sample 10	Sample 12	PC
②	Sample 2	Sample 4	Sample 6	Sample 8	Sample 10	Sample 12	PC
③	Sample 2	Sample 4	Sample 6	Sample 8	Sample 10	Sample 12	PC
④	Sample 2	Sample 4	Sample 6	Sample 8	Sample 10	Sample 12	PC

11) Setup the PCR protocol using the cycling parameters in Table 4.

Table 4 Cycling Parameters

Stage	Cycles	Temperature	Time	Data collection
1	1	95℃	5min	/
2	15	95℃	25s	/
		64℃	20s	/
		72℃	20s	/
3	31	93℃	25s	/
		60℃	35s	FAM and HEX/VIC
		72℃	20s	/

12) Start the PCR run immediately.

13) When the PCR run finished, analyze the data according to the "Results Interpretation" procedures

4. Result Interpretation

Before the data analysis, the following items should be checked:

1) For NTC: The FAM Ct values of Reaction Mixes ①~④ and HEX/VIC Ct values of Reaction Mix ④ should be ≥ 31. If not, the data is *INVALID*. The sample should be retested.

2) For Positive Control: The FAM Ct values of Reaction Mixes ①~④ and HEX/VIC Ct values of Reaction Mix ④ should be < 24. If not, the data is *INVALID*. The sample should be retested.

3) For the reference gene assay (HEX/VIC signal) in Reaction Mix ④ for each sample:

   a) The HEX/VIC Ct value should be ≤20.

   b) If the HEX/VIC Ct value >20, this indicates RNA degradation or presence of PCR inhibitors. The sample should be retested with increased or re-extracted RNA, as there may be false negative results.

Analyze the fusion assay for each sample:

4) Record the FAM Ct value of Reaction Mixes ①~④ for each sample:

   c) If the FAM Ct value of Reaction Mix ①~④ ≥30, the sample is determined as Negative (No *RET* fusion detected) or under the LOD (limit of Detection) of the kit.

   d) If any FAM Ct value of Reaction Mix ①~④ <30, the sample is determined as Positive (*RET* fusion detected).

5) The sample may contain two or more fusion patterns simultaneously.

Performance Characteristics

The performance characteristics of this kit were validated on Stratagene Mx3000P™, ABI7500, LightCycler480 II, Bio-Rad CFX96, and Rotor-Gene Q/6000 (72 wells).

1) Limit of detection:

   The limit of detection was established by testing plasmid DNA with 9 *RET* fusions. The results show the limit of detection for each *RET* fusion was 25 copies/μL.

2) Specificity:

   Specificity of the kit was established by testing 8 *RET* negative reference controls which were prepared with wild-type DNA (4 controls) or with wild-type RNA (another 4 controls), the tests gave negative results and with 100% concordance rate.

3) Accuracy:

   Accuracy of the kit was established by testing 9 *RET* gene fusion positive reference controls which were prepared with plasmid with *RET* fusions, the test gave corresponding positive results and with 100% concordance rate.

4) Precision:

   Precision of the kit was established by testing of the precision reference control for 10 repeats; the test gave positive results with the FAM and HEX Ct value < 24 and Ct's CV (%) ≤ 10%.

Limitations

1) The kit is to be used only by personnel specially trained with PCR techniques.
2) The results can be used to assist clinical diagnosis, combining with other clinical and laboratory findings.
3) The kit has been validated for use with extracted RNA from NSCLC patient FFPE tissue.
4) The kit can only detect 9 *RET* gene fusions listed in the appendix.
5) Reliable results are dependent on proper sample processing, transport, and storage.
6) The sample containing degraded RNA may affect the ability of the test to detect *RET* fusions.
7) Samples with negative result (No *RET* Fusion Detected) may harbor *RET* fusions not detected by this assay.

References

1. Ju Y S *et al*.,*Genome Res*.2012;22:436-65.
2. Kohno T *et al*.,*Nat Med.2012*;18:375-7.
3. Takeuchi K *et al*.,*Nat Med*.2012;18:378-81.

Symbols

1)		Authorized Representative in the European Community
2)		In Vitro Diagnostic Medical Device
3)		Manufacturer
4)		Catalogue Number
5)		Batch Code
6)		Use By
7)		Contains Sufficient for <n> Tests
8)		Temperature Limitation
9)		Consult Instructions For Use
10)		Keep Dry
11)		This Way Up
12)		Fragile, Handle With Care

Appendix

***RET* Gene Fusions Detected by the Kit**

Reagent	Spliced Gene & Exon				RET Spliced Exon
L-RET Reaction Mix ①	*KIF5B* exon15	*KIF5B* exon16	*KIF5B* exon22	*KIF5B* exon23	12
L-RET Reaction Mix ②	*KIF5B* exon24				8&11
L-RET Reaction Mix ③	*CCDC6* exon1	*NCOA4* exon6			12
L-RET Reaction Mix ④	*KIF5B* exon15				11