Claims

1. A portable device for detecting and/or quantifying a target molecule in a sample, the device comprising:

   a sample chamber comprising an outer shell and a rotor for receiving the sample comprising the target molecule;

   a plurality of red, green, blue (RGB) LEDs for generating illumination and inducing an optical signal of the target molecule;

   a plurality of RGB sensors for detecting the optical signal of the target molecule; and

   a microcontroller communicatively coupled to the plurality of RGB sensors for connecting to an external device and transferring data;

   wherein an integrated LED of each RGB sensor has been removed.

2. The device of claim 1, wherein each RGB sensor is selected from the group comprising TCS230, AS73211, TCS3200, TCS3400, TCS34715, TCS34727, colorPAL, SEN-11195, EV3, GY-33, VCNL4010, VCNL4040, MAX44009, ISL29125, BH1745, APDS-9960, AS7262, and AS7263;

   optionally wherein the device comprises 2-10 RGB sensors, or more than 10 RGB sensors through the incorporation of a transistor switch; and

   optionally wherein each RGB sensor detects an optical signal selected from the group consisting of a fluorescent signal, a colorimetric signal, an absorbance signal, a luminescence signal, a bioluminescence signal, and a chemiluminescence signal.

3. The device of claim 2, wherein the optical signal is within the visible light range or the invisible light range.

4. The device of claim 1, wherein each RGB LED is selected from the group comprising gallium nitride (GaN), indium gallium nitride (InGaN), gallium phosphide (GaP), and gallium arsenic (GaAs), wherein each RGB LED generates illumination with a wavelength of 300–1100 nm,

   optionally wherein each RGB LED is positioned without a filter between the RGB LED and the sample, or each RGB LED is positioned with a filter between the RGB LED and the sample; and

   optionally wherein the plurality of RGB LEDs are positioned at different locations and distances to the sample.

5. The device of any one of claims 1-4, wherein there are 2, 3, 4, 5, 6, 7, 8, 9, 10 or more RGB sensors; and

   optionally wherein the ratio of the number of RGB sensors to the number of RGB LEDs is 1:1 or 1:2.

6. The device of claim 1, wherein the microcontroller is selected from the group comprising a single-board Arduino Uno microcontroller (Arduino), ARM, AVR, 8051, PIC, XMEGA, SAM, MSP430, AT MEGA, NXP, STM, LPC, GD, STM8 and STM32,

   optionally wherein the microcontroller comprises a Bluetooth module selected from the group comprising SPP-C, SPP2-0, CC2541, BT04-A, BK3231, BC417, CH-05, CH-08, CH-06, CH-10C, CH-07, CH-09, NRF52832, NRF51822, JDY-09, CC2541, HM-19, and HM-17 for wireless communication with the external device, or a portal for cable connection with the external device, and

   optionally wherein the external device is selected from the group comprising a smartphone, a tablet, a computer, a server or a cloud platform.

7. The device of claim 1, further comprising a thermal cycler thermally coupled to the sample chamber, wherein the thermal cycler comprises a heating element selected from the group comprising ceramic, carbon, iron, steel, glass, strip, silicon rubber, and belt, and a fan selected from the group comprising axial, centrifugal, tangential, and composite fan, and

   optionally wherein the microcontroller comprises a temperature sensor and a microcontroller program, being associated with the thermal cycler and configured to control a temperature profile of the sample chamber to perform a reaction.

8. The device of claim 7, wherein the temperature profile is 1-100 °C, preferably 10- 90 °C.

9. The device of claim 7 or 8, wherein the thermal cycler is suitable for use with a Taq polymerase; and

   optionally wherein the thermal cycler is suitable for use with an isothermal enzymes suitable for a reaction selected from the group comprising recombinase polymerase amplification (RPA), loop-mediated isothermal amplification (LAMP), Rolling Circle Amplification (RCA), Multiple Displacement Amplification (MDA), Transcription-mediated Amplification (TMA), Nucleic Acid Sequence-Based Amplification (NASBA), Ligase Chain Reaction (LCR), and Helicase-dependent Amplification (HDA).

10. The device of claim 1, wherein the rotor has a capacity to receive 1-200 samples, preferably 1-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80, 80-90, 90-100, 100-150, or 150-200 samples;

    optionally wherein the device has a capacity of 1, 2, 3, or 4 rotors; and

    optionally the device further comprises a motor and a speed control for rotating the rotor.

11. The device of claim 1, wherein the outer shell has a body made of a material selected from the group comprising aluminum, plastic, polycarbonate, steel, ABS, PLA, PET,

PETT, Nylon, PVA, HIPS, PA, HDPE, POM, PP, TPU, TPE, PMMA, PVC, and PEEK;

optionally wherein the rotor has a body made of a material selected from the group comprising aluminum, plastic, polycarbonate, and steel, ABS, PLA, PET, PETT, Nylon, PVA, and HIPS;

optionally wherein the device is operatable with a battery selected from the group comprising cadmium battery, Lithium polymer battery, Lithium ion battery, Nickel–metal hydride battery, Nickel-cadmium battery, Mercury battery, Zinc-carbon battery, and Silver oxide battery;

optionally wherein microcontroller is programmed for fault detection to automatically monitor and identify faults, and

optionally wherein the device further comprises a LCD screen for displaying results and errors, the LCD screen being selected from the group comprising character, graphic, TFT, OLED LCD, PLS, LTPS, IGZO, AMOLED, and RETINA.

12. The device of claim 1, wherein the sample is a biological, chemical or environmental sample,

optionally wherein the biological sample is obtained from a tissue sample, saliva, blood, plasma, sera, stool, urine, sputum, mucous, lymph, synovial fluid, cerebrospinal fluid, ascites, pleural effusion, seroma, pus, or swab of skin or a mucosal membrane surface or a combination thereof;

optionally wherein the chemical sample is obtained from a pharmaceutical substance, a chemical reagent, a cosmetic product, an industrial effluent, a pollutant, a hazardous material, a polymer, an adhesive, a solvent, an oil, a gas, a metal alloy, a nanomaterial, a fuel, a cleaning agent, a dye, or a combination thereof; and

optionally wherein the environmental sample is obtained from a food, a beverage, a paper surface, a fabric surface, a metal surface, a wood surface, a plastic surface, a soil sample, a freshwater sample, a waste water sample, a saline water sample, exposure to atmospheric air or other gas sample, or a combination thereof.

13. The device of claim 12, wherein the biological, chemical or environmental sample is a crude sample and/or wherein the target molecule is not purified or amplified from the sample.

14. The device of claim 12 or 13, wherein the sample contains a microbe selected from a bacteria, a virus, an archaea, a protozoa, a fungi, an algae, a slime mode, a lichen, and a prion,

optionally wherein the virus is selected from a group consisting of a double-stranded DNA virus, a single-stranded DNA virus, a double-stranded RNA virus, a positive sense RNA virus, a negative sense RNA virus, and a retrovirus,

optionally wherein the virus is selected from a group consisting of a coronavirus, an Ebola virus, measles, SARS, Chikungunya virus, Marburg, MERS, Dengue, Lassa, influenza, rhabdovirus, HIV, a hepatitis virus (including hepatitis A, B, C, D, or E), an influenza virus (including an influenza A or influenza B), a human respiratory syncytial virus, Sudan ebola virus, Bundibugyo virus, Tai Forest ebola virus, Reston ebola virus, Achimota virus, Aedes flavivirus, Aguacate virus, Akabane virus, Alethinophid reptarenavirus, Allpahuayo mammarenavirus, Amapari mmarenavirus, Andes virus, Apoi virus, Aravan virus, Aroa virus, Arumwot virus, Atlantic salmon paramyxovirus, Australian bat lyssavirus, Avian bomavirus, Avian metapneumovirus, Avian paramyxoviruses, penguin or Falkland Islandsvirus, BK polyomavirus, Bagaza virus, Banna virus, Bat herpesvirus, Bat sapovirus, Bear Canon mammarenavirus, Beilong virus, Betacoronavirus, Betapapillomavirus 1-6, Bhanja virus, Bokeloh bat lyssavirus, Boma disease virus, Bourbon virus, Bovine hepacivirus, Bovine parainfluenza virus 3, Bovine respiratory syncytial virus, Brazoran virus, Bunyamwera virus, Caliciviridae virus. California encephalitis virus, Candiru virus, Canine distemper virus, Canine pneumovirus, Cedar virus, Cell fusing agent virus, Cetacean morbillivirus, Chandipura virus, Chaoyang virus, Chapare mammarenavirus, Colobus monkey papillomavirus, Colorado tick fever virus, Cowpox virus, Crimean-Congo hemorrhagic fever virus, Culex flavivirus, Cupixi mammarenavirus, Dengue virus, Dobrava-Belgrade virus, Donggang virus, Dugbe virus, Duvenhage virus, Eastern equine encephalitis virus, Entebbe bat virus, Enterovirus A-D, European bat lyssavirus 1-2, Eyach virus, Feline morbillivirus, Fer-de- Lance paramyxovirus, Fitzroy River virus, Flaviviridae virus, Flexal mammarenavirus, GB virus C, Gairo virus, Gemycircularvirus, Goose paramyxovirus SF02, Great Island virus, Guanarito mammarenavirus, Hantaan virus, Hantavirus Z10, Heartland virus, Hendra virus, Hepatitis A/B/C/E, Hepatitis delta virus, Human bocavirus, Human coronavirus, Human endogenous retrovirus K, Human enteric coronavirus, Human genital-associated circular DNA virus- 1, Human herpesvirus 1-8, Human mastadenovirus A-G, Human papillomavirus, Human parainfluenza virus 1-4, Human paraechovirus, Human picomavirus, Human smacovirus, Ikoma lyssavirus, Ilheus virus, Influenza A-C, Ippy mammarenavirus, Irkut virus, J-virus, JC polyomavirus, Japanese encephalitis virus, Junin mammarenavirus, KI polyomavirus, Kadipiro virus, Kamiti River virus, Kedougou virus, Khujand virus, Kokobera virus, Kyasanur forest disease virus, Lagos bat virus, Langat virus, Lassa mammarenavirus, Latino mammarenavirus, Leopards Hill virus, Liao ning virus, Ljungan virus, Lloviu virus, Louping ill virus, Lujo mammarenavirus, Luna mammarenavirus, Lunk virus, Lymphocytic choriomeningitis mammarenavirus, Lyssavirus Ozemoe, MSSI2Y225 virus, Machupo mammarenavirus, Mamastrovirus 1, Manzanilla virus, Mapuera virus, Marburg virus, Mayaro virus, Measles virus, Menangle virus, Mercadeo virus, Merkel cell polyomavirus, Middle East respiratory syndrome coronavirus, Mobala mammarenavirus, Modoc virus, Moijang virus, Mokolo virus, Monkeypox virus, Montana myotis leukoenchalitis virus, Mopeia lassa virus reassortant 29, Mopeia mammarenavirus, Morogoro virus, Mossman virus, Mumps virus, Murine pneumonia virus, Murray Valley encephalitis virus, Nariva virus, Newcastle disease virus, Nipah virus, Norwalk virus, Norway rat hepacivirus, Ntaya virus, O'nyong-nyong virus, Oliveros mammarenavirus, Omsk hemorrhagic fever virus, Oropouche virus, Parainfluenza virus 5, Parana mammarenavirus, Parramatta River virus, Peste-

des-petits- ruminants virus, Pichande mammarenavirus, Picomaviridae virus, Pirital mammarenavirus, Piscihepevirus A, Porcine parainfluenza virus 1, porcine rubulavirus, Powassan virus, Primate T-lymphotropic virus 1-2, Primate erythroparvovirus 1, Punta Toro virus, Puumala virus, Quang Binh virus, Rabies virus, Razdan virus, Reptile bomavirus 1, Rhinovirus A-B, Rift Valley fever virus, Rinderpest virus, Rio Bravo virus, Rodent Torque Teno virus, Rodent hepacivirus, Ross River virus, Rotavirus A-I, Royal Farm virus, Rubella virus, Sabia mammarenavirus, Salem virus, Sandfly fever Naples virus, Sandfly fever Sicilian virus, Sapporo virus, Sathuperi virus, Seal anellovirus, Semliki Forest virus, Sendai virus, Seoul virus, Sepik virus, Severe acute respiratory syndrome-related coronavirus, Severe fever with thrombocytopenia syndrome virus, Shamonda virus, Shimoni bat virus, Shuni virus, Simbu virus, Simian torque teno virus, Simian virus 40-41, Sin Nombre virus, Sindbis virus, Small anellovirus, Sosuga virus, Spanish goat encephalitis virus, Spondweni virus, St. Louis encephalitis virus, Sunshine virus, TTV-like mini virus, Tacaribe mammarenavirus, Taila virus, Tamana bat virus, Tamiami mammarenavirus, Tembusu virus, Thogoto virus, Thottapalayam virus, Tick-borne encephalitis virus, Tioman virus, Togaviridae virus, Torque teno canis virus, Torque teno douroucouli virus, Torque teno felis virus, Torque teno midi virus, Torque teno sus virus, Torque teno tamarin virus, Torque teno virus, Torque teno zalophus virus, Tuhoko virus, Tula virus, Tupaia paramyxovirus, Usutu virus, Uukuniemi virus, Vaccinia virus, Variola virus, Venezuelan Vesicular stomatitis Indiana virus, WU Polyomavirus, Wesselsbron virus, West Caucasian bat virus, West Nile virus, Western equine encephalitis virus, Whitewater Arroyo mammarenavirus, Yellow fever virus, Yokose virus, Yug Bogdanovac virus, Zaire ebolavirus, Zika virus, or Zygosaccharomyces bailii virus Z viral sequence, Canine Parvovirus, Canine Distemper Virus, Canine Coronavirus, Canine Influenza Virus, Feline Herpesvirus, Feline Calicivirus, Feline Leukemia Virus, Feline Immunodeficiency Virus, Canine Adenovirus - Type 1 and Type 2, Canine Herpesvirus, Tobacco Mosaic Virus, Potato Virus Y, Tomato Spotted Wilt Virus, Cucumber Mosaic Virus, Potato Virus X, Barley Yellow Dwarf Virus, Bean Common Mosaic Virus, Maize Dwarf Mosaic Virus, Soybean Mosaic Virus, Citrus Tristeza Virus, Rice Yellow Mottle Virus, Plum Pox Virus, Turnip Mosaic Virus, Aphid-Transmitted Yellow Dwarf Viruses, Cotton Leaf Curl Virus, Papaya Ringspot Virus, Cassava Mosaic Virus, Rice Tungro Virus, Apple Mosaic Virus, Sugarcane Mosaic Virus or a combination thereof,

optionally wherein the virus is a coronavirus,

optionally wherein the coronavirus is SARS-CoV-2; and

optionally wherein the bacteria is a Gram-positive bacterium or a Gram-negative bacterium selected from the group consisting of *Staphylococcus aureus, Staphylococcus epidermidis, Staphylococcus saprophyticus, Streptococcus pneumoniae, Streptococcus pyogenes, Streptococcus agalactiae, Enterococcus faecalis, Enterococcus faecium, Bacillus anthracis, Bacillus cereus, Clostridium botulinum, Clostridium perfringens, Clostridium difficile and Clostridium tetani, Corynebacterium diphtheria, Listeria monocytogenes, Escherichia coli, Pseudomonas aeruginosa, Acinetobacter baumannii, Chlamydia trachomatis, Yersinia pestis, Neisseria gonorrhoeae, Neisseria meningitidis, Moraxella*

catarrhalis, Haemophilus influenzae, Klebsiella pneumoniae, Legionella pneumophila, Proteus mirabilis, Enterobacter cloacae, Serratia marcescens, Helicobacter pylori, Salmonella enteritidis, Salmonella typhi, and Vibrio cholera, *Brucella abortus, Brucella melitensis, Brucella suis, Brucella canis, Brucella ovis, Brucella neotomae, Mycoplasma mycoides, Clostridium perfringens, Mycobacterium avium Salmonella spp., Pasteurella multocida, Haemophilus parasuis, Actinobacillus pleuropneumoniae, Yersinia pestis, Francisella tularensis, Bacillus anthracis, Coxiella burnetiid, Listeria monocytogenes, Clostridium chauvoei, Campylobacter spp., Chlamydia psittaci, Anaplasma marginale, Leptospira spp. Causes leptospirosis, Bordetella bronchiseptica, Clostridium perfringens, Staphylococcus intermedius, Bartonella henselae, Chlamydophila felis, Mycoplasma spp, Pasteurella multocida, Erwinia amylovora, Xanthomonas spp., Xanthomonas axonopodis, Ralstonia solanacearum, Pectobacterium and Dickeya spp., Agrobacterium tumefaciens, Pseudomonas syringae, Pseudomonas syringae pv. lachrymans, Xanthomonas campestris pv. campestris, Xanthomonas oryzae, Clavibacter michiganensis, Xylella fastidiosa, Pantoea spp., Burkholderia glumae, Xanthomonas citri, Xanthomonas translucens, Xanthomonas fragariae, Xanthomonas hortorum, Clavibacter michiganensis, Pseudomonas syringae* or a combination thereof.

15. The device of claim 1, wherein the target molecule is selected from the group consisting of a nucleotide, a polynucleotide, a nucleoside, a nucleic acid, a nucleic acid analogue, a peptide, a polypeptide, a protein, an antibody, a hormone, a salt, a metal, and a compound that produces color in a solvent, and

    optionally wherein the nucleic acid is a RNA or a DNA from a virus of claim 14, or a RNA or a DNA from a bacteria of claim 14.

16. The device of claim 15, wherein the device is for detecting 2-10 target molecules from a sample in a single tube, wherein each target molecule is selected from the group comprising a nucleic acid, an antigen, and an antibody; and

    optionally wherein the device is for detecting 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 or more target molecules from a sample in a single tube, wherein each target molecule is selected from the group comprising a nucleic acid, an antigen, and an antibody.

17. The device of claim 1, wherein the device is suitable or configured for one or more of amplification of nucleic acids including analysis of polymerase chain reactions including quantitative polymerase chain reactions, reverse transcription polymerase chain reaction, protein analysis, ligand analysis, fluorescence analysis of chemical reactions, or fluorescence analysis in the presence of particles, polymers, hydrogels, and nanostructures, biomolecule interactions, detection of specific nucleic acid sequences, fluorescence protein analysis, bioluminescence enzymatic reactions, and chemiluminescence reactions,

    optionally wherein the reverse transcription polymerase chain reaction is for protein analysis, ligand analysis, biomolecule interactions, detection of specific nucleic acid sequences, fluorescence protein analysis, bioluminescence enzymatic reactions,

chemiluminescence reactions, fluorescence analysis of chemical reactions or fluorescence analysis in the presence of particles, polymers, hydrogels, and nanostructures;

optionally wherein the device is suitable or configured for clustered regularly interspaced short palindromic repeats and CRISPR associated protein (CRISPR-cas)-based nucleic acid, antigen, antibody, and aptamer or chemical detection,

optionally wherein the CRISPR based nucleic acid detection uses an effector complex comprising a Cas protein and at least one CRISPR RNA (crRNA) capable of specifically binding to a target nucleic acid molecule, and

optionally wherein the Cas protein is selected from the group consisting of Cas 9, Cas12a, Cas12b, Cas12c, Cas12d, Cas13a, Cas13b, Cas13c, Cas13d, Cas12e, and Cas14.

18. A method of detecting and/or quantifying a target molecule in a sample, using the device of any one of claims 1-17, the method comprising:

providing the sample comprising the target molecule in the rotor;

generating illumination and inducing the optical signal of the target molecule by the plurality of RGB LEDs;

detecting the optical signal of the target molecule by the plurality of RGB sensors; and

transferring the data to the external device by the microcontroller.

19. The method of claim 18, wherein the method is performed in one hour or less.

20. A method of monitoring viral or bacterial disease outbreaks and/or evolution, comprising performing a method as claim 18 or 19.