WHAT IS CLAIMED IS:

1. A sensor system (100) comprising:

a sensing element (238) comprising a substrate (302), sensing electrodes (310, 312) supported by the substrate (302), a sensing material (236) over the sensing electrodes (310, 312), and a multi-energy-delivering element (304) coupled to the sensing material (236) and configured to deliver different types of operational energy directly to the gas sensing material (236);

excitation and detection circuitry (314) coupled to the sensing electrodes (310, 312) and the multi-energy-delivering element (304); and

a controller (316) coupled to the excitation and detection circuitry (314), wherein the controller (316) is configured to cause the excitation and detection circuitry (314) to achieve multi- gas differentiation with one-, two-, or higher-dimensional detection by

applying an alternating current through the sensing electrodes (310, 312) at one or more operational frequencies for excitation of the sensing material (236), and

applying at least one type of operational energy to the gas sensing material (236) via the multi-energy-delivering element (304), wherein at least one type of operational energy has at least two levels.

2. The sensor system (100) of claim 1, where:

a first dimension is selected from one of three types of operational energy such as thermal, radiant, or acoustic;

one or both of a second or third dimension is selected from other types of operational energy such as thermal, radiant, or acoustic and is not the same as the first dimension;

and

wherein an alternating current is applied through the sensing electrodes (310, 312) at one or more operational frequencies for excitation of the sensing material (236).

3. The sensor system (100) of claim 1, wherein the multi-dimensional detection achieves differentiation between multiple analyte gases, or achieves quantification of multiple analyte gases, or achieves sensitivity of the sensor (114) to the different analyte gases, or achieves stable baseline of the sensor (114), or achieves short warm-up time of the sensor (114) or a combination of thereof.

4. The sensor system of claim 1, wherein repeatedly applying at least two different operational energy levels to the energy-delivering element (304) comprises sequentially and periodically applying at least two different operational energy levels to the energy- delivering element (304).

5. The sensor system (100) of claim 1, wherein the sensing material (236) comprises a metal oxide semiconductor material.

6. The sensor system (100) of claim 1, wherein the multi-energy-delivering element (304) produces thermal energy.

7. A method comprising:

repeatedly applying, by a controller (316), at least two different operational voltages to a heater (304) of a sensor system (100);

continuously applying, by the controller (316), alternating current through sensing electrodes (310, 312) at one or more operational frequencies of the sensor system (100) for excitation of sensing material (236) of the sensor system (100);

measuring gas responses of the sensing element (238), by the controller, under the excitation with the alternating current through sensing electrodes (310, 312) at one or more operational frequencies at the first operational voltage that is applied to the heater (304);

measuring gas responses of the sensing element (238), by the controller (316), under the excitation with the alternating current through sensing electrodes (310, 312) at one or more operational frequencies at the second operational voltage that is applied to the heater (304);

detecting gas, by the controller, based on repeatedly applying at least the two different operational voltages to the heater (304) and continuously applying alternating current through the sensing electrodes (310, 312) at one or more operational frequencies for excitation of the sensing material (236); and

achieving differentiation, by the controller (316), between multiple gases.

8. The method of claim 7 comprising:

- achieving quantification, by the controller (316), of the multiple analyte gases;
- achieving sensitivity, by the controller (316), of the sensor (114) to the different analyte gases;
- achieving stable baseline, by the controller (316), of the sensor (114) during differentiation and quantification of different analyte gases; or
- achieving, by the controller (316), a short warm-up time of the sensor (114).

9. The method of claim 7, wherein a warm-up time of the sensor (114) is either in a range from about 10 seconds to about 300 seconds or in a range from about 10 seconds to about 60 seconds.

10. The method of claim 7, wherein:

- repeatedly applying at least two different operational voltages to the heater (304) comprises sequentially and periodically applying at least two different operational voltages to the heater (304); or
- an improved response stability is achieved with a reduced power consumption as compared to non-selected responses from the sensing material (236)by operating with a nominal operational voltage applied to the heater (304) and at a below-nominal operational voltage applied to the heater (304), wherein non-selected responses from the sensing material (236) comprise resistance measurement responses from the sensing material (236).

11. A sensing system (100) comprising:

a sensing element (238) comprising a substrate (302), sensing electrodes (310, 312) supported by the substrate (302), sensing material (236) over the sensing electrodes (310, 312), and a heater (304) supported by the substrate (302);

an excitation and detection circuitry (314) coupled to the sensing electrodes (310, 312) and the heater (304); and

a controller (316) coupled to the excitation and detection circuitry (314), wherein the controller (316) is configured to cause the excitation and detection circuitry (314) to achieve multi- gas differentiation with one-, two-, or higher-dimensional detection by

repeatedly applying at least two different operational voltages to the heater (304), and applying an alternating current through the sensing electrodes (310, 312) at one or more operational frequencies for excitation of the sensing material (236).

12. The sensing system (100) of claim 11, wherein repeatedly applying at least two different operational voltages to the heater (304) comprises sequentially and periodically applying at least two different operational voltages to the heater (304).

13. The sensing system (100) of claim 11, wherein the sensing material (236) comprises a metal oxide semiconductor material.

14. The sensing system (100) of claim 13, wherein the metal oxide semiconductor material comprises a single-metal oxide, a metal oxide with two differently sized cations, a metal oxide formed as 0-D, 1-D, 2-D, or 3-D nanostructures, or a metal oxide formed as nanoparticles, nanowires, nanotubes, nanobelts, nanosheets, or nanocubes.

15. The sensing system (100) of claim 11, wherein:
- an improved response stability is achieved with a reduced power consumption as compared to non-selected responses from the sensing material by operating with a nominal operational voltage applied to

the heater (304) and at a below-nominal operational voltage applied to the heater (304), wherein non-selected responses from the sensing material (236) comprise resistance measurement responses from the sensing material (236); or
- an improved multi-gas differentiation is achieved by repeatedly applying at least two different operational voltages to the heater (304) and analyzing real and imaginary responses of the impedance spectra of the sensing material (236) as compared to non-selected responses from the sensing material (236), wherein non-selected responses from the sensing material (236) comprise resistance measurement responses from the sensing material (236).