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[0060] As used herein and in the appended claims, the singular forms "a", "and", and "the" include plural referents unless the context clearly dictates otherwise.

[0061] The foregoing detailed description of the present invention is provided for the purposes of illustration and is not intended to be exhaustive or to limit the invention to the embodiments disclosed. Accordingly, the scope of the present invention is defined by the appended claims.

What is claimed is:

1. A graphene device comprising:
- a first gate structure;
- a second gate structure that is transparent or semi-transparent; and
- a bilayer graphene coupled to the first and second gate structures, the bilayer graphene situated at least partially between the first and second gate structures.

2. The graphene device of claim **1** wherein the second electronic gate structure is transparent or semi-transparent within an infrared regime.

3. The graphene device of claim **1** wherein the second electronic gate structure comprises an insulating layer and an electrode.

4. The graphene electronic device of claim **3** wherein the insulating layer comprises Al_2O_3.

5. The graphene electronic device of claim **3** wherein the electrode comprises Pt.

6. A method of investigating semiconductor properties of bilayer graphene comprising:
- providing a bilayer graphene device comprising:
  - a first gate structure;
  - a second gate structure that is transparent or semi-transparent; and
  - bilayer graphene coupled to the first and second gate structures, the bilayer graphene situated at least partially between the first and second gate structures; and
- probing the semiconductor properties of the bilayer graphene device using a light source to illuminate the bilayer graphene at least partially through the second gate structure.

7. The method of claim **6** wherein the broad spectrum light source emits at least partially within an infrared regime.

8. The method of claim **6** wherein the lights source is a broad spectrum light source.

9. The method of claim **6** wherein the lights source is a light emitting diode.

10. The method of claim **6** wherein the lights source is a laser.

11. The method of claim **6** wherein the lights source is a synchrotron.

12. A method of operating a graphene device comprising:
- providing a bilayer graphene device comprising:
  - a first gate structure;
  - a second gate structure; and
  - bilayer graphene coupled to the first and second gate structures, the bilayer graphene situated at least partially between the first and second gate structures; and
- producing a bandgap of at least 50 mV within the bilayer graphene by applying first and second electric fields to the bilayer graphene using the first and second gate structures, respectively.

13. The method of claim **12** wherein producing the bandgap produces a bandgap of at least 100 mV.

14. The method of claim **12** wherein producing the bandgap produces a bandgap of at least 150 mV.

15. The method of claim **12** further comprising adjusting the bandgap by changing at least one of the first and second electric fields produced by the first and second gate structures, respectively.

16. The method of claim **12** further comprising introducing carriers selected from the group consisting of holes and electrons by changing at least one of the first or second electric fields produced by the first and second gate structures, respectively.

17. The method of claim **16** further comprising maintaining a constant bandgap while introducing the carriers.

18. The method of claim **12** further comprising detecting a response within the bilayer graphene due to an incident photon.

19. The method of claim **12** further comprising producing a photon by injecting holes and electrons into the bilayer graphene between the first and second electrodes.

20. The method of claim **12** wherein the bilayer graphene is at least partially suspended between the first and second gate structures.

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