compound semiconductor devices **302**, devices **1002** and devices **610**) to provide the desired functionality (block **1614**).

[0048] The second set of compound semiconductor devices **1002** may be made of the same material or a different material than compound semiconductor devices **302**. Representatively, in one embodiment, compound semiconductor devices **302** and compound semiconductor devices **1002** may be made of the same or different III-V semiconductor materials. For example, compound semiconductor devices **302** may be made of gallium arsenide (GaAs) and compound semiconductor devices **1002** may be made of indium gallium phosphide (InGaP). Alternatively, one of compound semiconductor devices **302** or compound semiconductor devices **1002** may be made of a group IV material (e.g. germanium or silicon) while the other is made of a compound group III-V material. Alternatively, both may be made of the same or a different group IV material.

[0049] Once the desired number of compound semiconductor devices are stacked and bonded to receiving structure **602**, compound semiconductor devices **302** and **1002** can be processed further, mostly with back-end of the line processes (e.g., deposition/patterning of dielectrics and metals) to complete the desired device configuration. In one embodiment, the temperatures used for the further processing should remain below critical levels (e.g., 250 degrees Celsius) to prevent disruption of the stack of compound semiconductor devices **302** and **1002**.

[0050] For example, in one embodiment illustrated in FIG. **11**, metal contacts **1102** are deposited and patterned onto compound semiconductor devices **302** and **1002**. Metal contacts **1102** (e.g., solder bumps) can be formed on each of compound semiconductor devices **302** and **1002** to connect compound semiconductor devices **302** and **1002** with a final receiving handle substrate **1302**, as shown in FIG. **13**. Handle substrate **1302** can be a temporary handle (e.g., a tape) or a final assembly substrate.

[0051] Prior to attaching devices **302**, **610** and **1002** to handle substrate **1302**, portions of receiving structure **602** between receiving devices **610** are removed to form trenches **1202** as illustrated in FIG. **12**. These portions may be removed through any of the previously discussed etching processes (e.g., a chemical etch).

[0052] At the end of device processing, receiving substrate **604** is removed to release the resulting devices **1402** (i.e., receiving devices **610**, compound semiconductor devices **302** and compound semiconductor devices **1002**), as shown in FIG. **14**. In one embodiment, a chemical etching process (e.g., wet etch or plasma etch) is used to remove release layer **606**. In one embodiment, xenon difluoride (XeF_2) can be used as an etchant. Since each of devices **610**, **302** and **1002** have dielectric layers **402**, **902** and **1004** all around their surfaces, they are not affected by the etchant. Only release layer **606** is exposed to the etchant and will be etched away. The presence of holes **612** allows the etchant to reach release layer **606** from its bottom surface, in addition to its exposed side/edge surfaces. As a result, the release process can be accelerated. In another embodiment, receiving substrate **604** is solid, without through holes **612**, and the release etchant etches the release layer from the side/edge surfaces only.

[0053] After devices **1402** are released from receiving substrate **604** with handle substrate **1302**, devices **1402** can be separated and re-assembled for a specific configuration, without needing dicing or sawing of the parts.

[0054] In some embodiments, after release of the processed devices **1402**, receiving substrate **604** can be made available for further reuse. Reusing receiving substrate **604** reduces fabrication and materials costs. This is in contrast to a conventional wafer, which is consumed by the process of device fabrication and cannot be reused.

[0055] The resulting devices **1402** are integrally formed devices that are made of different materials having different functionalities. Representatively, devices **1402** can be devices having microelectronic functionalities typically associated with silicon semiconductor devices as well as optoelectronic functionalities typically associated with compound semiconductor devices. For example, devices **1402** may have the functionality of detectors, sensors, photovoltaic (PV) cells, integrated circuits (ICs), micro-machine parts, micro-mechanical parts or electronic components in combination with the light emitting and/or detecting functionalities typically associated with compound semiconductor devices.

[0056] FIG. **15** schematically illustrates a cross-sectional view of another embodiment for forming a device in which compound devices are bonded to receiving structure positioned along opposing sides of a receiving substrate. Representatively, each of the process steps and components described in references to FIGS. **1-10**, which were performed on a first side **1502** of receiving substrate **604**, may be duplicated and performed on second side **1504** of receiving substrate **604**. In this aspect, in addition to the previously discussed components formed on first side **1502**, second side **1504** may have formed thereon release layer **1506**, receiving device **1508** having receiving devices **1510** and a stack of compound devices **1512** and **1514** bonded to receiving devices **1510**. Each of receiving devices **1510** and compound devices **1512** and **1514** may be covered with dielectric layer **1516**. The resulting device stack **1501** formed on first side **1502** and device stack **1503** formed on second side **1504** may be formed simultaneously or one formed followed by formation of the other. The further processing steps described in reference to FIGS. **11-14** may also be performed on device stack **1503** to form devices similar to devices **1402**.

[0057] While certain embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that the invention is not limited to the specific constructions and arrangements shown and described, since various other modifications may occur to those of ordinary skill in the art. For example, although various process steps are described in a particular order, it is contemplated that one or more of the steps may be performed in a different order. The description is thus to be regarded as illustrative instead of limiting.

What is claimed is:

1. A method comprising:

forming a release layer over a donor substrate;

forming a plurality of devices made of a first semiconductor material over the release layer;

applying a first dielectric layer over the plurality of devices such that all exposed surfaces of the plurality of devices are covered by the first dielectric layer;

attaching the plurality of devices to a receiving structure made of a second semiconductor material, the receiving structure having a receiving substrate attached to a surface of the receiving structure opposite the plurality of devices; and