Hybrid substrate from wafer direct bonding

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Many modern opto-electronic devices are made from compound semiconductor alloys. More often than not these alloys do not come as readily available wafer substrates but are constructed by depositing thin monocrystalline layers onto a carrier substrate by means of hetero-epitaxy. For hetero-epitaxial synthesis to be successful though these substrates must be able to act as growth templates. It is also rare to find a substrate of matching crystallographic structure which simultaneously fits the electrical or optical requirements for optimal device performance. In optimising the overall performance of the opto-electronic device, one is left try to disentangle the conflicting constraints placed on the substrate. This usually results in selecting a substrate that meets the requirements of hetero-epitaxy, depositing the layer structure of the device onto this substrate and then trying to transfer the device layers or even the processed devices onto an alternative substrate. Examples of this are the epitaxial lift-off of devices, or the transfer of the completed device layer by wafer direct bonding onto another substrate. These processes are unusual for opto-electronic fabs; as depending on the process sequence they either reverse the polarity of the device and thus may require changes in the device packaging, or they involve the handling of the expensive thin and fragile layers and from a manufacturing standpoint are not desirable. In addition the diffusion during bond strengthening annealing or soldering may degrade the designed layer profiles or the contacts.

We suggest using a hybrid substrate for device epitaxy which comprises of a thin “seeding” layer of suitable alloy composition and a “stiffener” substrate chosen for its opto-electronic properties. The “seeding” layer is first grown on a conventional substrate and then transferred to the “stiffener” by wafer direct bonding.

We hereby present an exploratory investigation of such a hybrid subs

trate for hetero-epitaxy.