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# Air-bridge interconnection and bondpad process for non-planar compound semiconductor devices

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**Abstract**

We present a versatile metallic air-bridge process that can be used either for high relief compound semiconductor devices or interconnections schemes. Our technology uses conventional contact photolithography and does not require dry-etching techniques allowing a fast fabrication time, reliable production and cost effectiveness. It is based on the use of only one photoresist and one electroplating step.


*Keywords:* Interconnection technique; Air-bridge bondpad; Compound semiconductor; Non-planar devices

## 1. Introduction

Bondpad interconnection on non-planar devices and/or multi-electrode interconnection, such as encountered in ridge lasers, VCSELs, HBTs, photodiodes… can be made using processing steps involving polymides [1,2], $SiO_2$ [3] or planarizing materials such as benzocyclobutene [4,5]. However, all these methods require dry-etching techniques in order to open up via holes for the contact metallizations. We present here a versatile technique that can be used either for "classical" bondpad metallization or air-bridges processes and based on the use of only one photoresist and one electroplating step. It has been developed for non-planar devices with mesa height in the order of 3.5 μm but can be easily adapted to other heights. A previous study [6] was developed for devices fabricated on N+ type substrate and based on the use of two different photoresists (Microchem Nano™ SU8 and PMGI-SF11). A SU8 film represents the stand of the bondpad and PMGI-SF11 forms the support of the bridge between

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the device to be connected and the SU8-pedestal. We present here a solution for devices fabricated on semi-insulating substrate where bondpads are directly deposited on the substrate.

## 2. Bondpad process

At this stage of device fabrication, the active parts of the device, i.e., ohmic or schottky contacts are assumed to be already done. Small pads or metallic areas for interconnection purpose are so available on the device. As an example, we take here the case of a P–I–N photodiode array on which multiple P- and N-contacts are ready for interconnection. We will describe the process that has been developed to connect together all the P-contacts by air-bridges during the top level metallization. Each P-contact is on top of a P–I mesa which height is 3.5 μm.

### 2.1. Bridge definition

This process is based on one specific Microchem Nano™ PMGI-SF19 resist physical property: PMGI resist can be flowed by the postbake process in order to produce a sloped sidewall profile in the patterned openings. Here, we simply apply this PMGI property to fabricate bridges between active parts of the devices and the bondpad areas located on the semi-insulating substrate. Parameters were chosen here to reach a 5-μm thick film [7]. PMGI resists can be directly patterned using deep-UV source or using a bilayer process [7]. For our example, we used an AZ 1518 intermediate mask and a standard i-line exposure. Special care shall be taken during the development process of this resist in order to avoid the formation of an interface layer between AZ and PMGI resists [6]. After the patterning of the 1518 film, the so-defined patterns are used as lithography mask and the wafer is flood-exposed with a deep-UV source. The wafer is then flood-exposed with i-line and developed in AZ 726 MIF in order to remove the AZ 1518 photoresist mask as well as to pattern the PMGI-bridge. At this stage of fabrication, we have defined on the one hand the openings of the PMGI resist on the P- and N-contacts and on the other hand the PMGI bridge between devices and semi-insulating substrate, as can be seen in Fig. 1. The P-contact area is 4 μm by 35 μm and the opening area is theoretically 2.4 μm by 33.4 μm. Nevertheless, the thickness of the PMGI film that is used requires a development process that tends to widen these openings. As a consequence, openings can be larger than the P type contact area. This can be distinguished in Fig. 1(b), mainly on the smallest dimension of the opening. The gap between two interconnection pads is between 3 and 20 μm.

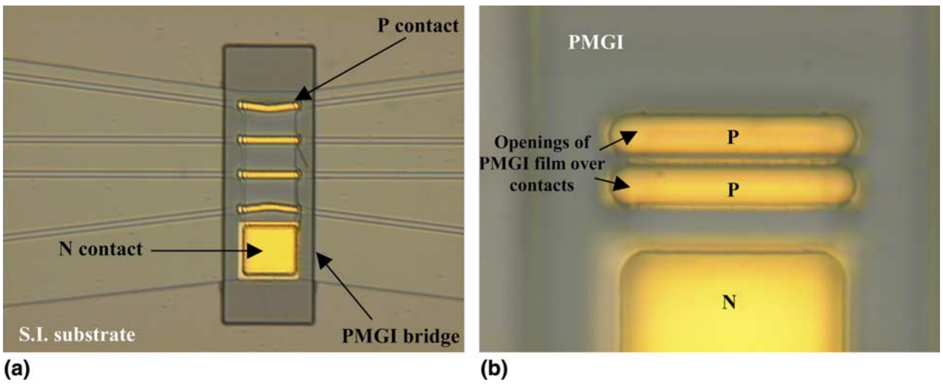


Fig. 1. Microscope observation of a four (a) and a two P–I–N photodiode array (b). On (b), openings wider than contact surface areas can be distinguished.