Semiconductor Back-End Manufacturing Process Utilizing a Silicon-Based Resist and Non-Patternable Polyimides

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INTRODUCTION

Photosensitive polyimides (PSPI) are used as an alternative for traditional non-patternable polyimides (PI) to simplify the process flow and reduce cycle time by eliminating photoresist patterning, plasma etch and resist strip process steps. Despite having beneficial properties, PSPI suffers from several disadvantages over traditional PI when used as a permanent layer for passivation and insulation or as a stress buffer in back-end process modules.

For example, electrical and passivation properties, moisture permeation resistance and film stress of PSPI are inferior compared to PI materials. Also, the lithography performance, especially resolution, of thick PSPI is often insufficient to meet the requirements of advanced devices. In this poster recent achievements in silicon-based resist materials and the advantages when used in combination with PI will be presented.

RESULTS

PiBond's negative tone silicon-based resist extends the use of non-patternable polyimides in modern backend applications. A silicon-based resist with high etch selectivity can be coated thinner than conventional organic photoresists with low etch selectivity. This enables increased pattern resolution, which has become a limiting factor for use of thick organic resists or PSPI in backend applications where resolution up to 1-2µm is required. A typical process sequence using PiBond's SAP 200 resist in combination with PI is shown in Figure 1.

SAP 200 key features

- Negative tone silicon-based resist for i-line or ghi-line
- Fully compatible with standard lithography process flows and commonly used EBR/BSR and developer chemicals
- High >1:20 etch selectivity against O_2-based plasma etch processes
- Easy removal by wet strip

CD measurement data from a focus exposure matrix test and SEM images from 1-2µm L/S structures are shown in Figure 2.

SAP 200 to PI etch selectivity using O_2 based plasma chemistries is 1:20 or higher (depending on etch process). This allows

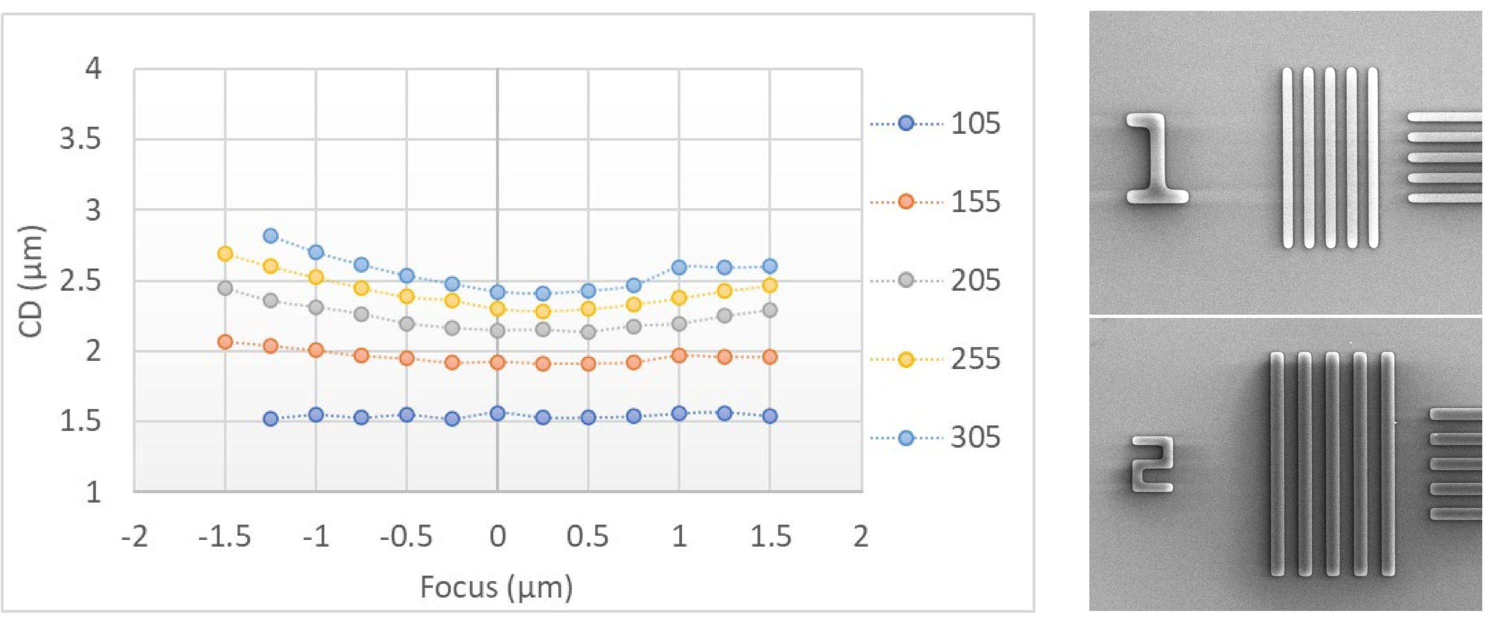

Figure 2*. SAP 200 2µm line Bossung plot and SEM images from 1-2um L/S.* Film exposed using Canon FPA-3000 i4 i-line stepper with NA 0.65 and developed with AZ 726MIF developer.

etching of 10µm or thicker polyimide layers with good process margin using a 0.5µm thick SAP 200 film. Efficient resist removal after etch can be achieved using alkaline photoresist wet strip solutions between 40°C-60°C temperatures. Example SEM images after etch and strip are shown in Figure 3. When extremely long PI etch processes are used, a dilute 0.1-0.5% HF solution can be used to first remove the plasma hardened resist surface. This will further increase the wet stripper removal efficiency.

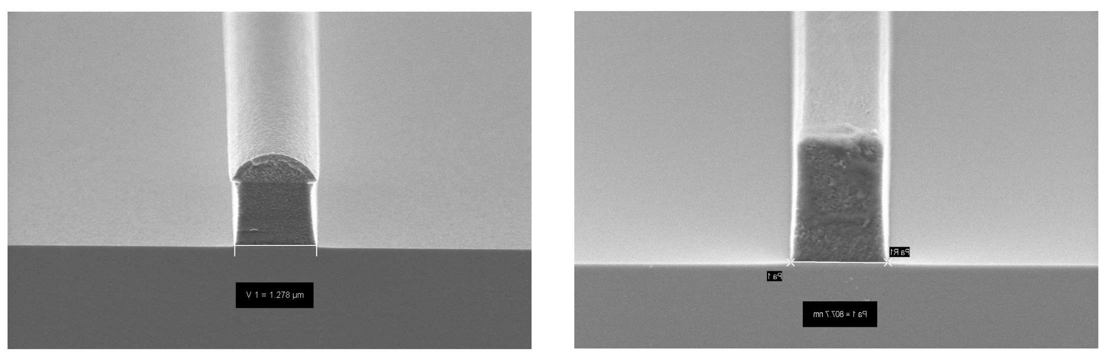

Figure 3*. SAP 200 pattern transfer to an organic underlayer, images after etch and strip*

Typical via CD Bossung plot and via & pillar SEM images are shown in Figure 4.

SUMMARY

PiBond's negative tone silicon-based resist SAP 200 extends the use of non-patternable polyimides to modern backend processes where pattern resolution of 1-2µm is required. High >1:20 etch selectivity to PI permits use of thin resist layers thereby improving lithography process window and resolution compared to thick PSPI and organic photoresists. The inferior passivation and electrical properties of PSPI can also be avoided by using PiBond's SAP 200 resist in combination with industry proven non-patternable polyimides.

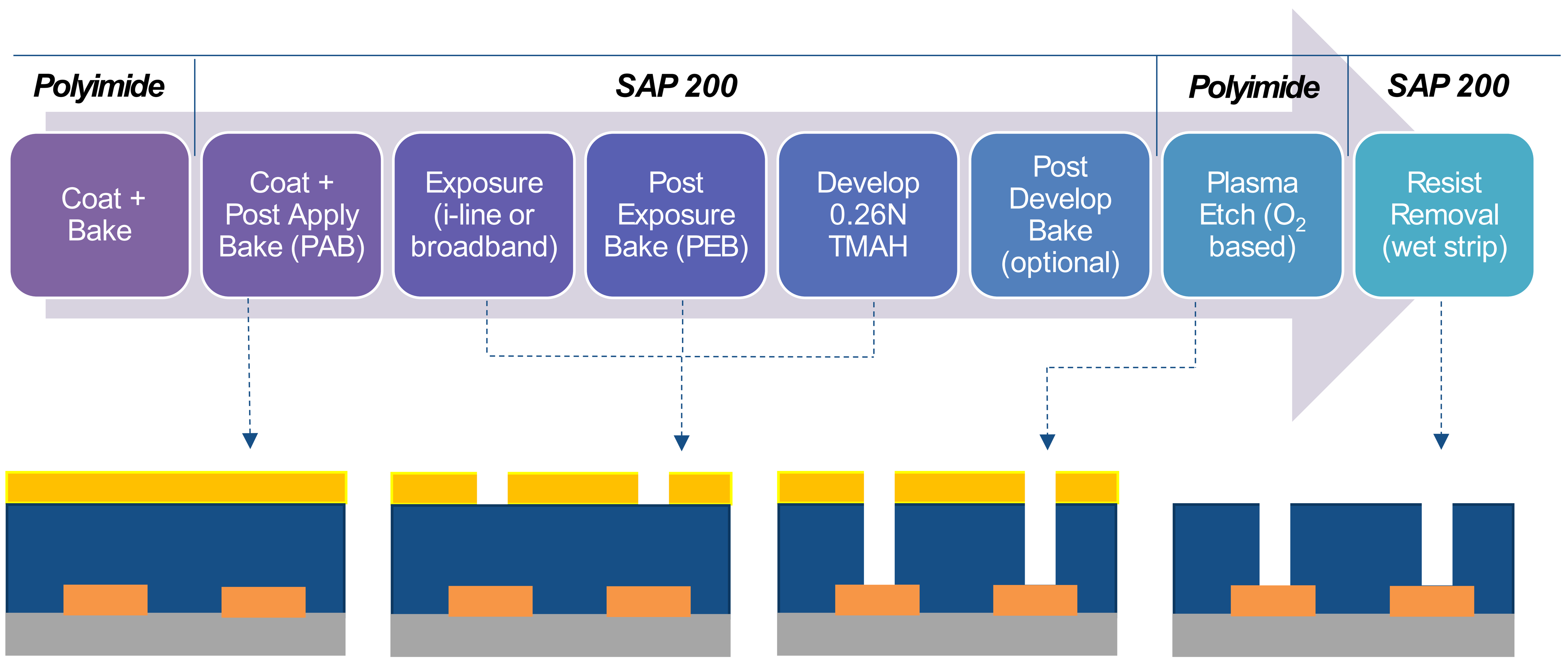

Figure 1*. Process flow for polyimide via open using PiBond's SAP 200 resist*

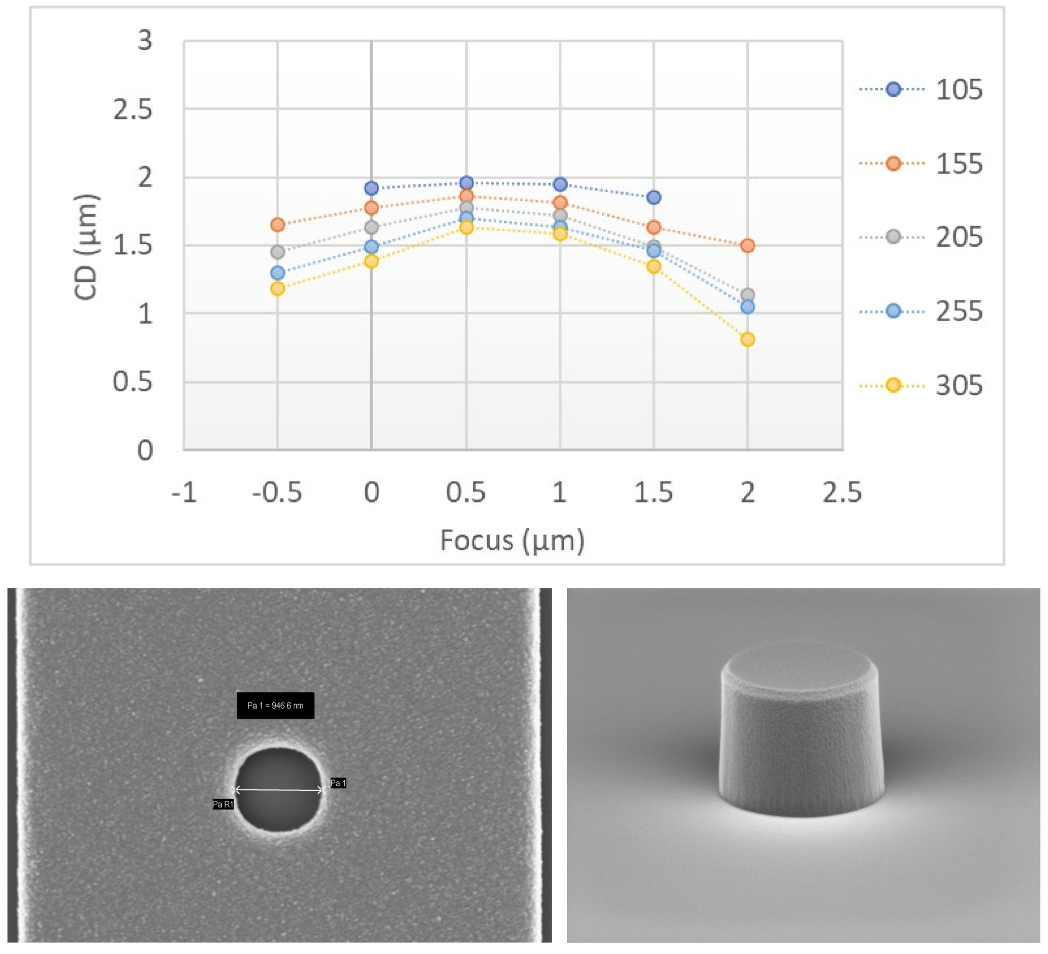

Figure 4*. Via CD and SEM images of via and pillar patterns*

PiBond is a leading innovator of silicon and metal oxide based polymeric thin film materials used in the semiconductor, photonics applications and displays. Our vision is to ensure the success of our customers and their products through superior, innovative materials as well as consistent service and quality.

We are committed to world-class manufacturing operations with ISO 9001 and ISO 14001 certified quality and environmental management system. PiBond is a member of the Responsible Care initiative.