# RF 및 Microwave 응용을 위한 SU-8 공정 연구

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# A Study on SU-8 Fabrication Process for RF and Microwave Application

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**Abstract** : This paper describes a procedure developed to fabricate negative photo resist SU-8 to a semi-insulating (SI)-GaAs-based substrate. SU-8 is attractive for micromachine multi-layer circuit fabrication, because it is photo-polymerizable resin, leading to safe, and economical processing. This work demonstrates SU-8 photo resist can be used for RFIC/MMIC application.

**Key Words** : SI-GaAs-based Substrate, SU-8

## 1. Introduction

SU-8 is a photosensitive organic resin that behaves like a negative photo resist and can be processed up to a millimeter thick. SU-8 is a well established material used within micromechanical processing. Its unique capable of high aspect ratios when exposed in the "near UV" spectrum has been well documented [1]. SU-8 can be used as a sacrificial material for selective etching [2] or as a self sacrificial layer [3-4], a mould for casting of other materials or electroplating [1,2,5], and as a structural material integral to the fabricated device [5-6]. SU-8 has been applied to wafer-level packaging systems. Franosch et al. [7] explored using SU-8 to replace ceramic cavity packages in silicon based bulk-acoustic-wave filters. SU-8 air-cavities are created above the active areas of the filter to reduce cost and size while improving performance. Chou et al. [8-9] experimentally study the use of SU-8 as the bonding layer for silicon-to-silicon wafer bonding. The low-temperature process could be used to create 3D circuit components. Venkateshan et al. [10] propose using SU-8 in a micromachined isolation scheme where walls of SU-8 separated patch antennas and the isolation improvement is measured.

In this paper, SU-8 photo resist is proposed to be used for RFIC/MMIC application. To evaluate the moisture resistance of the SU-8 films, we perform a temperature and humidity test at 85°C with 85% relative humidity during 1,000 hours and just a litter failures are observed. Finally, the method that can thoroughly remove bubbles during SU-8 coating process is also employed.

## 2. Fabrication Process

In this paper, a modified SU-8 manufacturing process is presented. To obtain maximum reliability, the wafer should be clean and dry prior to applying the SU-8. The wafer is rinsed using $HF:NH_4F:H_2O$ solution. After that, the wafer is dehydrated in a convection oven at 200°C for 30 minutes.

Firstly, SU-8 is spun at 500 r.p.m. for 20 seconds, 800 r.p.m. for 20 seconds, and 1,000 r.p.m. for 30 seconds during the coating process. Then, the deposited SU-8 is soft-baked in an open hot plate for 10 minutes at 65°C, 10 minutes at 80°C, and 5 minutes at 95°C to evaporate the solvent and density the film and [11], after that, a photolithograph process with 150 mJ/cm$^2$ exposure energy is carried out. The exposing time is divided into two intervals of 10 seconds. The time between the intervals is 60 seconds. By this way, it is possible to avoid the excessive heating of the surface induced by long exposure time, which causes loss of resolution. Following exposure, a post-exposure bake (PEB) must be performed to selectively cross-link the exposed portions of the film. PEB is carried out for 2 minutes at 95°C and after that, the SU-8 is developed for 3 minutes. Following the development process, the wafer is rinsed briefly with isopropyl alcohol (IPA), and then dries with a gentle stream of nitrogen. SU-8 properties should not change in thermal or humid environment for RFIC/MMIC application; so a final curing step is needed for 30 minutes at 200°C in the electron beam-curing machine.

## 3. Results and Discussion

The moisture resistance performance is very important for RFIC/MMIC. To evaluate the moisture resistance of the SU-8 films, we perform a storage test at 85°C with 85% relative humidity. Just a little failures are observed in the samples with SU-8 in the storage test at 85°C and 85% relative humidity [12]. In the future, a Highly Accelerated Temperature/Humidity Stress Test (HAST) will be needed to further approve the reliability of SU-8 films.

The failures are due to the bubbles. It is found only the failed devices have some bubbles, through which moisture percolates. When SU-8 is spin-coated, bubbles will occur in the groove, which is shown in Figure 1. This is because air in the groove can't leave rapidly when the viscous SU-8 films flood in. Our method to remove the bubbles is by using a vacuum oven where the air pressure of inner SU-8 solution is higher than the outer. By putting the SU-8 coated wafer into the vacuum oven for 30 minutes, a majority of bubbles can be removed.

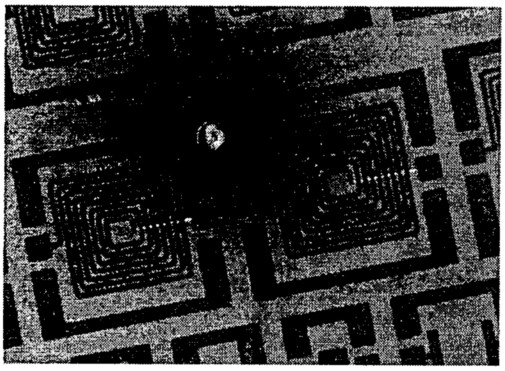

**Figure 1.** Random bubbles of SU-8 occurred in the groove

## 4. Conclusion

In this paper, SU-8 fabrication process is successfully proposed for RF and microwave application. The method that can thoroughly remove bubbles in the groove is also employed.

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