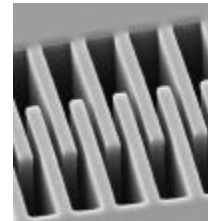


Tech Brief: September 2004

DRIE - Deep Reactive Ion Etching

DRIE stands for Deep Reactive Ion Etching and is a dry etch micromachining method. The use of ICP (inductively coupled plasma) allows for extremely high silicon etch rates using standard Cryo and Bosch processes. Cryo is a single step process done at cryogenic temperatures < -100 °C. Bosch is a cycling two-step process altering between deposition and etch steps done at $10-20$ °C. Bosch is the more popular of the two methods but each has its own advantages depending on your product's process requirements.

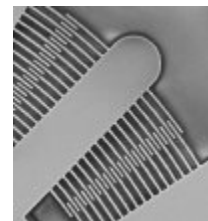
When should companies consider using DRIE and what are the main benefits? DRIE is currently the only etch method that can give a high etch rate, good mask selectivity, high aspect ratio, and vertical anisotropic etching required by many of today's MEMS processes. Older non-ICP plasma etchers and wet etches fail at achieving at least one of these four characteristics. Modern DRIE's have the following capabilities:



- High aspect ratios (up to 50:1)
- Deep etching ($10\mu\text{m}-700\mu\text{m}$)
- High etch rate ($4-20\mu\text{m}/\text{min}$)
- High selectivity (70-150: 1 for resist, 100-200: 1 for oxide masks)
- Anisotropic and isotropic etches ± 0.5 deg sidewall angle control

However, even with all of its strengths, the DRIE tool still has some challenges to overcome in the coming years. Compared to wet etching, DRIE is very expensive. To start, new tools cost between half a million to one million dollars. Furthermore, materials can also represent a significant cost, such as C_4F_8 for the Bosch process and liquid nitrogen for the Cryo process. Lastly, although DRIE provides us with high etch rates, it may require processing time of greater than one hour for deep Silicon etches ($>500\mu\text{m}$). This can lead to throughput issues even with multiple tools as currently only single wafers are processed at a time.

Micralyne has been aggressive in building DRIE know-how and has both Cryo and Bosch etching capabilities. As well, Micralyne recently purchased what we consider the most state-of-the-art production DRIE system available on the market – the Alcatel AMS200 I-Speeder. This tool is a high throughput and fully automated DRIE system that can give etch characteristics and performance that are not obtainable on many other systems, including a very high etch rate of up to $20\mu\text{m}/\text{min}$. This new tool is in addition to the



established Oxford DRIE system that is more focused on early stage product development programs.

In summary, DRIE has become extremely popular over the last couple of years as it is the only method capable of doing many of today's advanced MEMS designs. As MEMS product companies use DRIE more and more there will definitely be a need for new production equipment but as volumes begin to ramp up the business case will no doubt exist. Micralyne looks forward to continuing its leadership in DRIE and to helping the industry take the necessary steps to ensure a sustainable future for this exciting process technology. Micralyne currently has tens of customer projects that utilize DRIE and we would be more than happy to speak with you about the needs for your MEMS product.

- Jeff Raaphorst, Process Engineer, Micralyne Inc. -