

## The Effects of BakerClean® JTB-111 on Micro-roughness

As oxide thickness decreases, micro-roughness has been more closely linked to device performance. As a result, micro-roughness is now considered an important factor for fabrication facilities. Because of this fabrication facilities are driving for processes that yield smoother surfaces so that they can increase their yield.

To aid in the micro-roughness challenge, Mallinckrodt Baker has pioneered a revolutionary cleaning technique called BakerClean. The BakerClean process clearly lowers micro-roughness values when compared with the standard RCA cleaning process. This improved performance continues for the entire bath life as seen in the results below.

### EXPERIMENTAL

The micro-roughness measurements for the study were conducted using a High Amplitude Resonance Atomic Force Microscope.

The sample wafers were phosphorous doped virgin wafers pre-treated with piranha (90°C/10 minutes). To insure uniform starting surfaces, the initial micro-roughness, measured as the Root Mean Square (RMS), was determined for each wafer. Split lot testing was conducted with half the wafers going through a full RCA clean process and the remaining half going through the BakerClean process using JTB-111.

After the cleaning processes the micro-roughness of the surfaces was re-determined for each sample.

The RCA process was run as follows:

SC-1 (NH<sub>4</sub>OH:H<sub>2</sub>O<sub>2</sub>:H<sub>2</sub>O) (1/1/5), 70°C for 10 min.

SC-2 (HCl:H<sub>2</sub>O<sub>2</sub>:H<sub>2</sub>O) (1/1/5), 70°C for 10 min.

The BakerClean process was run as follows:

JTB-111 (JTB-111:H<sub>2</sub>O<sub>2</sub>:H<sub>2</sub>O) (1/0.22/5), 70°C for 10 min.

To provide a better comparison between the two cleaning processes, the RCA clean was not spiked as would be done in a typical fabrication facility. Eliminating the spiking step allows the effects of aging for solutions to be compared.

### RESULTS

The data in the table below indicates that the BakerClean with JTB-111 provides a 10% smoother surface in the fresh chemicals and a 70% smoother surface in the six hour aged chemicals. This is attributed to the degradation of H<sub>2</sub>O<sub>2</sub> in the RCA cleaning baths. The degradation does not allow oxide to be reformed. This results in pits or higher micro-roughness values. It is clear, however, that the BakerClean treatment with JTB-111 is providing a much smoother oxide on the wafer's surface.

**Table 1. Micro-Roughness**

TREATMENT	RMS (nm)	Standard Deviation
Reference wafer	0.182	0.005
Fresh BakerClean	0.214	0.003
Fresh RCA Clean	0.232	0.008
Aged BakerClean*	0.198	0.003
Aged RCA Clean*	0.330	0.010

\*Aged for 6 hours without spiking

The RMS average and the standard deviation found above is a result of three measurements on the same wafer. This data clearly shows that the BakerClean process with JTB-111 is providing a uniformly smoother surface.

## DISCUSSION

The most critical area that micro-roughness affects is the integrity of the gate oxide as measured by breakdown voltage. Of the many parameters that affect the gate oxide, a key measurement is the oxide's thickness. The thickness controls the capacitance at which the gate will function as well as the leakage current through the gate. The capacitance and leakage current will directly control the performance/speed of the circuit. If the surface of the interface is 'rough' then the oxide layer will vary in thickness, leading to a variance in the gate's performance. With BakerClean technology the oxide is smoother allowing the probability of higher yields in the process and an improved performance of devices.

Also, as analytical capabilities become more exact, a better understanding is being developed of how micro-roughness affects different aspects of the integrated circuit. This new understanding could stress better control of micro-roughness in other areas besides the gate oxide.

## CONCLUSION

The BakerClean process provides superior uniformly smooth surfaces when compared to the standard RCA cleaning process. Because of this, wafers cleaned by the BakerClean process with JTB-111 will provide a critical advantage for the Integrated Circuit Industry. The importance is fully realized in fabrication facilities where the critical dimensions of devices are dropping into the sub-micron region. BakerClean Technology is advancing the integrated circuit industry into the future with revolutionary cleaning chemistries. The benefits are reported in micro-roughness and other critical areas which are all part of the most crucial number that manufacturers are striving to push higher yield.

## APPLICATION NOTE

Mallinckrodt Baker, Inc. has a staff of applications engineers who are eager to provide customer support during the evaluation and the use of the BakerClean product line. Applications engineers are also available to assist in experimental design modification, process 'trouble-shooting', and materials. MBI's application staff is always available to answer any question about the J T Baker Product line.

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## PRODUCT LISTING:

Description	Product Numbers
BakerClean JTB-111	6422-05; 6432-09

## **Mallinckrodt Baker Microelectronic Materials**

### **U.S.A.**

Mallinckrodt Baker, Inc.  
222 Red School Lane  
Phillipsburg, NJ 08865  
Tel: 1-(800) 582-2537  
1-(908) 859-9346  
Fax: 1-(908) 859-6904  
E-mail: [micro.mbi@tycohealthcare.com](mailto:micro.mbi@tycohealthcare.com)  
Web: [www.jtbaker.com/micro](http://www.jtbaker.com/micro)

### **Europe**

Mallinckrodt Baker B.V.  
Teugseweg 20, P.O. Box 1  
7400 AA Deventer,  
The Netherlands  
Tel: 31-570-687500  
Fax: 31-570-687574  
E-mail: [jtbaker.nl@emea.tycohealthcare.com](mailto:jtbaker.nl@emea.tycohealthcare.com)  
Web: [www.jtbaker.com/micro](http://www.jtbaker.com/micro)

### **Malaysia**

Mallinckrodt Baker Sdn. Bhd.  
26 Jalan SS 26/13  
Taman Mayang Jaya  
47301 Petaling Jaya,  
Selangor D.E., Malaysia  
Tel: 60-3-7803-0378  
Fax: 60-3-7803-0405  
E-mail: [sales@tycohealthmbm.com](mailto:sales@tycohealthmbm.com)  
Web: [www.jtbaker.com/micro](http://www.jtbaker.com/micro)

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