



*Contamination Control and Minienvironment
Specialists*

April, 2003

Welcome to the second issue of the Bartlett Bay Consulting Newsletter. We hope that you find this interesting & informative reading. Please feel free to contact me with any questions or comments. If you wish to "un-subscribe" from future mailings, please use my e-mail link and type "UN-SUBSCRIBE" in the subject line, and your name will be removed from future mailings.

Steve Silverman, President
Bartlett Bay Consulting

New Clients

Bartlett Bay Consulting has recently been awarded a contract from Brooks Automation to act as a consultant to aid with Brooks' on-going contamination control studies.

Q & A

I welcome your feedback & questions! Starting with the next issue, I will be answering questions that I receive from you. In the next issue, I will address the following question:

“How is the backside PWP measurement performed,
and please explain to me how the specifications
of this test apply to my tool”

... It seems that the backside PWP test is a test that virtually nobody understands thoroughly. If you have any questions you wish to submit, please visit www.bartlettbayconsulting.com and use the form provided there.

Feature Article:

Measuring Particles on Wafers, Part 2: The Methodology, the Pain

In our February issue, we introduced to the Particle per Wafer Pass (PWP) test and how it is used by semiconductor companies (tool makers, OEMS, and Fabs). PWP specifications are getting increasingly tighter: This means that not only are the *specifications harder to meet*, but also the measurement *process* becomes *significantly more difficult*. In the last issue, we stated the purpose of this test was:

*“To determine the quality of a given environment by measuring the
number of particles added to a wafer during the handling
processes”*

Specifically, we are referring to those *handling processes* which take the wafer from its carrier (cassette, pod, FOUP) and passes it through a minienvironment into a process tool (metrology, etch, etc).

As PWP testing is a vital piece of the *specification process* for contamination control, it is necessary for those readers who are planning to run such a test to completely understand what goes into its execution, and this issue of the newsletter is a overview tutorial in the basic methodology involved. Furthermore, since *backside PWP* is generating a lot of interest lately, many fabs and OEMs are defining specifications for backside PWP as well as for frontside PWP. While this issue deals mainly with *frontside particles*, many of the items are applicable to *backside particles* as well.

For discussion purposes, the PWP process can be broken into 4 parts:

- 1) Preparation
- 2) Execution
- 3) Validation
- 4) Interpretation

In this issue, we will discuss the basic preparation and execution of the PWP frontside test. Subsequent issues will discuss:

- a) the statistical methods employed in processing and validation of the results,
- b) the interpretation of the results obtained, and
- c) how this test differs from the backside test.

These are all complicated issues, and each piece is like part of an elaborate puzzle: you really don't know the complete answer until you put all the pieces together.

Preparation

Planning and preparation are crucial steps in this difficult test, and there are 3 key elements involved

- 1) Pre-planning: organizing the test, purchasing the wafers, insuring the minienvironment meets its ISO specifications (usually airborne particle measurements are done prior to the PWP), setting up the measurement tools, cleanroom/gowning protocols, and a dozen other critically important factors. This step should not be underestimated as it often takes weeks to insure successful execution of the test/measurement
- 2) Purchasing the control and test wafers (1.)
- 3) Arranging for the Surface Particle Measurement Tool (2.)

(1.)

The "control" and "test" wafers are required for any measurements requiring statistical verification. This means at least 2 groups of wafers in at least 2 pods/FOUPS. This results in, of course, a high initial expense for wafers: for prime/best 200mm wafers, a 25 wafer cassette (often the minimum number you can buy) will cost ~\$2000-\$3000, while 25 prime 300mm wafers will cost \$7,500-\$10,000. So as you can see, the cost of this test is definitely significant.

(2.)

A further cost involves the measurement tool itself; while some companies own this tool, that is the exception, and most companies doing PWP measurements will have to either buy (>\$500,000!) or rent time from a company having such a tool. There are some very good tools available on the market for this measurement (Two of the best are KLA-Tencor's SP1 and ADE's AMS AWIS tool), and have high accuracy and precision at very small particle size (~60nm!).

Execution:

This is probably the most complicated and detailed piece of the puzzle, and to avoid confusion and lengthy descriptions, this newsletter edition is intended as an overview. (In performing an actual PWP test, the test details are dependent upon specific test goals).

1) Preparation of the wafers: transferring the wafers from the shipping cassettes/carriers to the pods or FOUPs: this is not a trivial step, as any *mishandling* of the wafers can contaminate them and ruin the whole test (to say nothing about the possibility of throwing away up to \$10,000 for wafers for just a simple mistake). Backside PWP testing involves the additional handling steps of inverting the wafer, which is often problematic.

2) Pre-measurement of the wafers: baselining the measurements *before* the actual cycling; in this step, it is necessary to carefully define the measurement tool “menu” to be sure that all the measurement parameters are correctly set (“bins”, exclusion zone, etc, etc). Usually backside measurements will involve an entirely different menu than frontside testing.

3) Cycling of the wafers: transferring the wafers from the pod/FOUP into the tool and back to the pod/FOUP involves very complex and well thought-out procedures. The wafers are transferred back and forth for anywhere from hundreds to thousands of cycles (the actual number of cycles depends upon the specifications and will be covered in the next newsletter when the statistics are discussed). *The backside PWP is completely different in this regard*, as usually it will involve just a single cycle.

4) Post-measurement of the wafers: the pre-counts are subtracted from the post counts to get the adders during the entire test, and that value is divided by the number of cycles which gives us the PWP value. In actuality, the control wafers may indicate that some particles need to be subtracted for the post-counts to compensate for the transportation, etc. adders.

5) The analysis of the PWP value: interpreting the meaning of the PWP value, and, if the test failed, trying to find the source of the problem. This and other pieces of the puzzle will be discussed in the next newsletter.

Homework assignment (*and you thought this tutorial was free???*):

In the next issue of the newsletter, I will discuss the statistical process used to

calculate the PWP cycles required for statistical significance. You will be better prepared for this tutorial, and will get more out of it, if you do some pre-investigation into your company's PWP specification.

If you don't know what your specification should be, there are three good sources:

- [ITRS](#) - International Technology Roadmap for Semiconductors
- [SEMI](#) - Semiconductor Equipment and Materials International
- [BBC](#) - Me! Bartlett Bay Consulting. See Contact Information below.

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