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Ergonomics in Semiconductor Wafer Manufacturing

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Abstract

In semiconductor wafer manufacturing, there are only a few processes but many steps. Each wafer must go through the processes multiple times (steps) and sometimes not in the same sequence. All the wafers in lot size of 25 pieces are transferred between the processes using an Automated Guided Vehicle from stocker to stocker. Then, the wafers are manually transferred to the processing tool. Although the tools are designed per SEMI S2/S8 standards [1,2], the equipment technician can get into awkward postures when performing the preventive maintenance. Both the manual material handling between the tools and awkward postures during preventive maintenance can pose an ergonomic challenge. However, some techniques can be used to minimize the impact. This paper shares the techniques which can ease ergonomic problems in semiconductor wafer manufacturing

Introduction

In semiconductor wafer manufacturing, there are 6 main processes, namely, Chemical-mechanical Planarization, Diffusion, Etch, Implant, Thin Film and Photolithography. Each wafer must step through these 6 processes multiple times in order to build the electronic circuitry on the wafer. Due to the circuitry design, the wafers do not go through the processes in the same sequence. Therefore, the wafer needs to be transferred between the processes using an Automated Guided Vehicle from stocker to stocker. Then, the wafers are manually transferred to the processing tool. In addition, the wafers are processed in lot size of 25 pieces in a pod, weighing 5 kg each.

Secondly, the tools need to be maintained regularly. Although they are designed per SEMI S2/S8 standards, the equipment technician can get into awkward posture when performing the preventive maintenance. Also, sometimes the technician is required to lift parts that are heavier than 20 kg. These activities are usually considered medium to low risk items, using SEMI S10 standards [3], due to the low frequency of occurrence and short duration of exposure.

Both of these situations can lead to backache for the manufacturing technician or the equipment technician. The impact can be minimized by introducing some simple techniques.

1. The manufacturing technician is required to carry the pod, with 25 wafers each, from the stocker to the tool. Instead, they can use a trolley. Also, the manufacturing technician is shown how to use the proper carrying technique for short distances.

2. Lifting is a common activity in manufacturing. The manufacturing technician performs up to 60 lifts per hour transferring the wafer pod from the stocker to the tool. They are trained in the proper lifting technique to avoid ergonomic problems

3. All the direct manufacturing activities are standing operations. To change the manufacturing technician's posture, they are given stools to sit down when they are using the computer for data entry or lot tracking.

4. For the equipment technician, the stretching program was introduced because their work is more ad hoc and can introduce awkward postures. Whenever the equipment technician feels any discomfort, he can stop safely and stretch to compensate for the awkward posture.

5. Heavy lifting is another potential ergonomic problem for the equipment technician. He can use a mechanical assist to do the heavy lifting.

Ergonomics in Manufacturing

In semiconductor wafer manufacturing, the manufacturing technician is required to carry the pod, with 25 wafers each, from the stocker to the processing tool. This manual carry can lead to potential ergonomic problems. For example, the pod is carried incorrectly as shown in Fig.1. Therefore, the manufacturing technician is trained in the correct way to carry the pod as shown in Fig.2. The best way to transfer the pods, of course, is to use a trolley as shown in Fig.3. The manufacturing technician is trained to use a trolley when transferring more than 1 pod or travelling long distance (>10 meters). By carrying the pod correctly and using a trolley, the manufacturing technician can reduce potential ergonomic problems

Fig.1: Incorrect way to carry a wafer pod

Fig.2: Correct way to carry a wafer pod

Fig.3: Best way to transfer wafer pods

In addition to pod carrying methods, the manufacturing technician is trained in the proper lifting technique as illustrated in Fig.4. Fig.5 shows the wrong lifting technique. The lifting analysis, using the NIOSH (1991) lifting equation [4] with a frequency of 60 lifts per hour and 5 kg pods, shows that the lifting index is below 1, a safe lift mainly due to the design of the stocker, tools and trolley. However, the manufacturing technician is trained to reduce twisting during the pod transfer as this act would contribute to the back pain. Again, training the manufacturing technician to use the proper technique can help to reduce ergonomic problems.

Fig.4: Proper lifting technique

Fig.5: Wrong lifting technique

All the direct manufacturing activities are standing operations as shown in Fig.6. To change the manufacturing technician's posture, they are given stools to sit down when they are using the computer for data entry or lot tracking as shown in Fig.7. This technique allows the manufacturing technician to change the posture and can help to reduce ergonomic problems

Fig.6: Manufacturing activities are standing operations

Fig.7: Sitting down for data entry or lot tracking

Ergonomics in Preventive Maintenance

The equipment technicians' preventive maintenance activities are more ad hoc. During the preventive maintenance activities, the equipment technician can get into awkward postures like that shown in Fig.8. The stretching program was introduced so that whenever the equipment technicians feel any discomfort, they can stop safely and stretch to compensate for the awkward postures. Taking micro breaks and stretching can help to promote better blood circulation [5] and reduce ergonomic related injuries [6]. Fig.9 shows a group performing stretching.

Fig.8: Awkward posture during preventive maintenance

Fig.9: Group performing stretching

Another method to reduce the awkward postures is to introduce new tools. These tools can be simple but innovative. Fig.10 shows the equipment technician reaching into the tool to remove a screw and the activity results in an awkward posture. By introducing an extension, the awkward posture can be reduced as shown in Fig.11. This simple extension is shown in Fig.12

Fig.10: Reaching into tool to remove screw

Fig.11: Using extension to remove screw

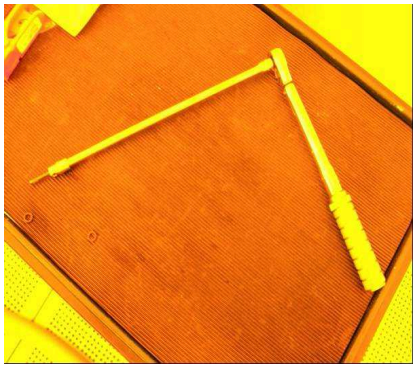

Fig.12: Extension for allen key

Finally, heavy lifting is a potential ergonomic problem for the equipment technician. Although the tools are designed per SEMI S2/S8 standards, sometimes the equipment technician is required to lift parts that are heavier than 20 kg. This activity is usually considered medium to low risk items due to the low frequency of occurrence and short duration of exposure. Therefore, a mechanical assist was introduced to help with the heavy lifting as shown in Fig.13.

Fig.13: Using a mechanical assist to lift a heavy part

Conclusion

In 2012, we saw a significant increase in the reported backache cases. From our data analysis shown in Fig.14, manufacturing was the highest in the pareto. Thus, we saw the need to introduce the training and techniques to reduce the ergonomics problems. Since the introduction of the training and techniques, we saw a decrease in the number of backache case overall and in individual modules.

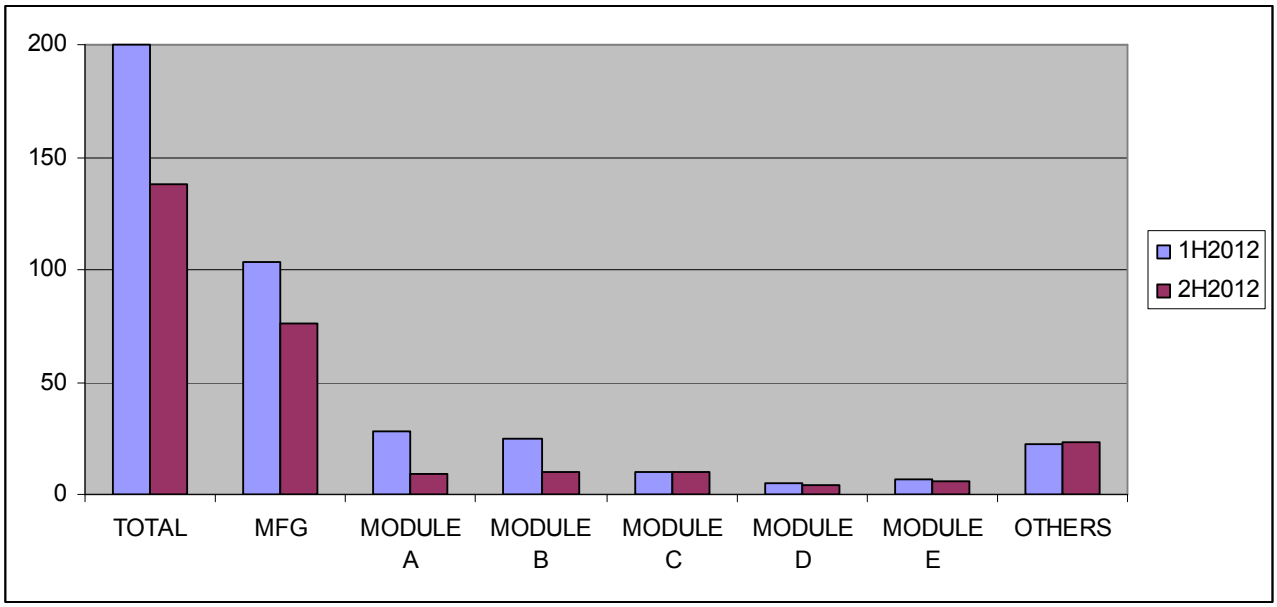

Fig.14: Backache data analysis in 2012

The training and techniques are only the beginning. We need to fine tune the training and techniques and proliferate them to the modules. In addition, we need to develop a more comprehensive ergonomics program that will include engineering and administrative controls.

References

[1] SEMI S2: Environmental, Health, & Safety Guideline for Semiconductor Manufacturing Equipment

[2] SEMI S8: Safety Guidelines for Ergonomic Engineering of Semiconductor Manufacturing Equipment

[3] SEMI S10: Safety Guideline for Risk Assessment and Risk Evaluation Process

[4] U.S. Department of Health and Human Services, NIOSH: Work Practices Guide for Manual Lifting, Cincinnati, OH (1981)

[5] Erik Peper and Katherine H. Gibney, Physiological Rationale for Microbreaks, Biofeedback (Spring 2005) pp. 38-39

[6] Sang D. Choi and Todd Woletz, Do Stretching Programs Prevent Work-related Musculoskeletal Disorders?, Journal of SH & E Research, vol.6 no.3 (Winter 2010)