The Green Activity of Back Grinding Process

Shinji Tsukino, Norio Sakaguchi, Seiji Tsunematsu, Mitsuhiro Ooki, Osamu Sakamoto

MMIC Engineering Department, Kagoshima Production Division 1, Sony Semiconductor Kyushu Corporation,
Kagoshima Technology Center, 5-1, Kokubu Noguchikita, Kirishima-shi, Kagoshima, 899-4393 Japan
E-mail: Shinji.Tsukino@jp.sony.com, Phone: +81-995-47-3940

Keywords: green, back grinding, recycle, reuse

Abstract

GaAs wafer back grinding process requires a lot of water and parts used for equipment are short life due to grinding wastes (GaAs debris). Also how to treat these wastes is important from environmental point. For green manufacturing, we introduced water recycling system in back grinding process and all the grinding wastes that can be used for Ga refinements are now collected for recycling. In addition, we succeeded to reuse wafer chuck table of back grinding equipment.

INTRODUCTION

Recently green management is going to be more activated in the world, Sony semiconductor Kyushu (SCK) is trying to reduce environmental impact based on our corporate policy also. We set a special activity day every month in order to make Black (company profit) and Green, trying to improve productivity and environmental impact. The result of activity is converted to financial benefit and CO_2 footprint saving so that employees can motivate themselves.

Figure 1-4 are the result of whole our factory green activity from fiscal year 2000 to 2009. Figure 1 shows trend of CO_2 footprint. Though the amount of production increases year by year, we succeeded to save energy by changing boiler fuel, air compressor machines and lightings. And also energy consumption for air conditioner in daytime is saved using ice blocks which are processed by night time surplus electrical power. Trend of water consumption is described in Figure 2. In our factory, we use pumped up water from our factory land for production. We are trying to reduce water consumption by optimizing pumping power and using recycled water. Trend of industrial waste is described in Figure 3. In 2001, we had reduced a lot of it, acid waste solution had been treated inside our factory and IPA waste solution had been recycled. After 2002, we had achieved 99% recycle rate. Trend of using paper is described in Figure 4. After corporate e-mail system introduced in 1994, PC user increased year by year and documents were computerized considerably, paper consumption has been reduced.

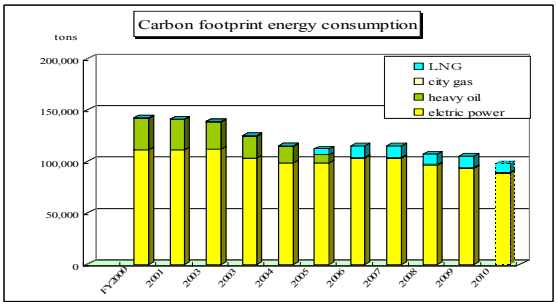

Fig.1 CO_2 footprint

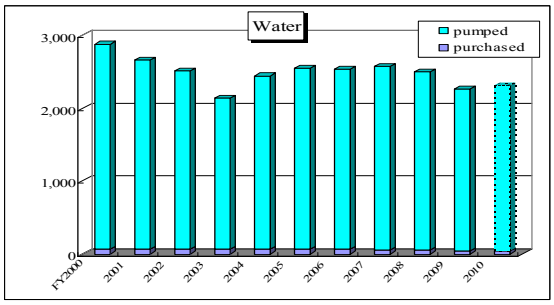

Fig.2 Water consumption

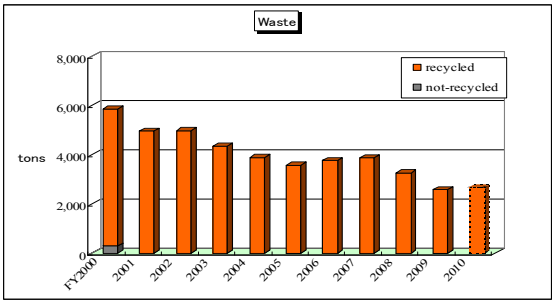

Fig.3 Amount of waste

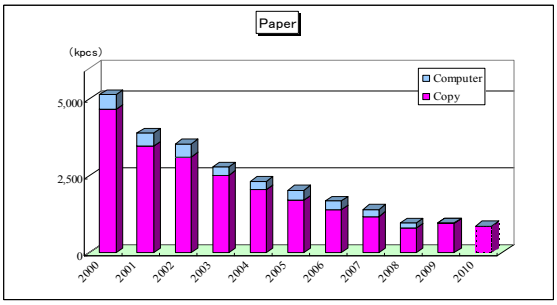

Fig.4 Paper consumption

THE ACTIVITY IN MMIC PRODUCTION

Typical activity in MMIC wafer production from 2009 is described in table 1. Increasing total number of chips from one wafer, improving yield and shrinking the chip size, is effective method for reducing environmental impact. Therefore we are trying to improve yield by reducing deviation of device characteristic and defects on wafer. And we are trying to shrink chip size by minimizing bond pad size and scribe streets width. For reducing energy of clean room, we have optimized air pressure difference between inside clean room and outside by controlling air flow. When the air flow was reduced to find optimum pressure balance, we had changed it slowly and needed to monitor a clean room pressure never went lower than maintenance area. And temperature and humidity must not over control limit. For water reduction, we are trying to shorten rinse time and reduce circulating water in non-loaded equipment. For the waste, trying to recycle almost all the materials. And also trying to make interconnect metal thinner and to reduce changing frequency of solution. In reducing paper, almost all the work records of each machine are computerized so that operators, managers and engineers can check data without using paper.

Table1 action for reducing environmental impact in production

Reduce	Activities
Pollutant	yield up, chip shrunk, solution life prolonging
Energy	building air pressure optimization
Water	rinse time shortening, circulation reduction
Waste	metal interconnect thinning, solution life prolonging
Paper	paper less work record

RECYCLING WATER SYSTEM IN BACK GRINDING

We introduced water recycling system, as described in Figure 5, for reducing water use and efficient back grinding wastes collection. By using this system we can minimize high quality water use in the whole factory. Recycled water's quality is not good enough for wafer surface processing but enough for back grinding. Amount of high quality water replenish to the recycling system is less than 1/100 of the whole water used in back grinding equipment.

Following is detailed explanation of each element of the system. Centrifugal machine is used for efficient collection of back grinding wastes. Conventional precipitation method requires much water and huge tank, so we selected centrifugal method. The centrifugal machines picture is shown. (Photo 1 and Figure 6) This machine can collect $5x10^{-3}m^3$ solid waste at 15000rpm. Two machines are introduced, so if one machine stops for maintenance another machine can continue back grinding. Almost all the GaAs wastes are collected and these wastes are used for Ga refinement. Wastes passed through centrifugal machine are collected by next 40um-class filter. Two filters are placed in parallel and work alternatively. Pressures both sides of a working filter are checked at all times to detect filter life end and system switches them automatically. Next element is the 2nd filter with microfiltration (MF) membrane. MF membrane system and its module are described in Figure 7 and Figure 8. MF membrane filtering size is several microns to 0.1um. The concentrated solution through inner side of the membrane is sent to MF membrane again after through buffer tank. MF module is rinsed by alkali solution regularly and reused. Water passed MF module is cooled down by heat exchange process, de-ionized by ion exchange, filtered by 0.2 um class Filter 3 then return to back grinding equipment.

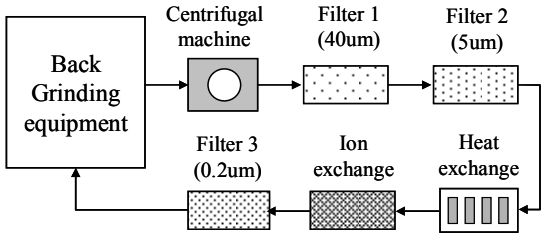

Fig.5 water recycling system

Photo.1 Centrifugal machine

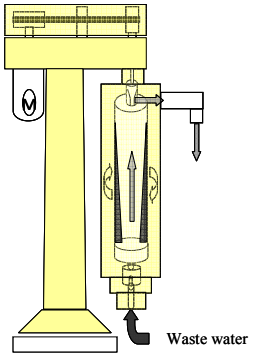

Fig.6 Centrifugal machine

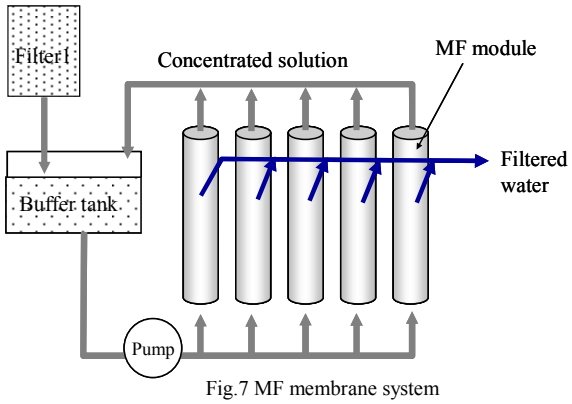

Fig.7 MF membrane system

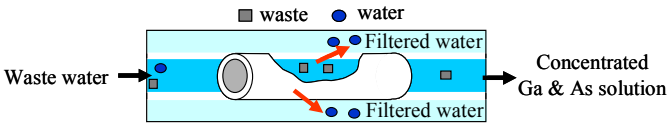

Fig.8 MF membrane module

REUSING OF WAFER CHUCK TABLE

Photo.2 shows wafer chuck table of back grinding equipment and Figure 9 is its cross section. The material of chuck table under wafer is porous, a wafer is held through the vacuum hole. The GaAs wastes deteriorate back grinding equipment parts. Because they soak into wafer chuck table, wafer chucking power on the table surface is decreased. Decreased wafer chucking power causes wafer fluttering, resulting in wafer back side surface rough, sometimes wafer edge gets chipped out or broken in the worse case. In order to regain chucking power, two measures have been introduced, grinding and cleaning chuck table.

Chuck table is grinded regularly. It is called self grinding and usually done for leveling chuck table. Chuck table is grinded about 50 um by self grinding. Therefore chuck table whose thickness comes to lower limit must be changed.

But in our equipment, sometimes chucking power can not regain by self grinding, so we have to change chuck table before coming to lower limit. We supposed that wastes deeply soak into chuck table, so we challenged removing wastes in chuck table. We had evaluated wafer chucking power by measuring water transit time as shown in Photo.3 and Figure 10. If wafer chucking power is decreased, transit time could be long, and if wafer chucking power regains, transit time could be short. We had examined several kinds of liquid solutions and found a cleaning method which regains the same chucking power as new one. Figure 11 shows the result. Horizontal axis is work numbers of back grinding wafer and vertical is water transit time. There are three wafer chuck tables in a back grinding equipment, all three tables were evaluated. Water transit time of new wafer chuck table is shorter than 100 seconds and used table shows longer time than that of new one. After cleaning (right side end in Figure 11), water transit time are the same as new one. By this cleaning method wafer chuck table becomes re-usable and prolongs life cycle 3 times.

CONCLUSIONS

GaAs wafer back grinding process requires a lot of water and produces many wastes. Water consumption is reduced 1/100 by using recycled water. And all the grinding wastes that can be used to Ga refinements are collected for recycling. In addition, we succeeded to reuse wafer chuck table of back grinding equipment and prolong life cycle 3 times.

Photo.2 Wafer chuck table

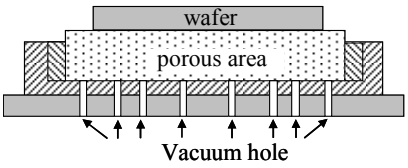

Figure 9 wafer chuck table cross section

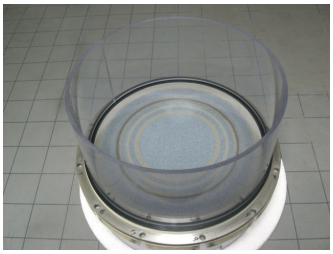

Photo.3 Evaluation method of chucking power

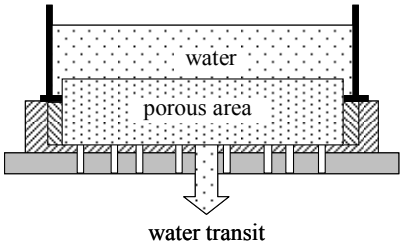

Figure10. Evaluation method of chucking power

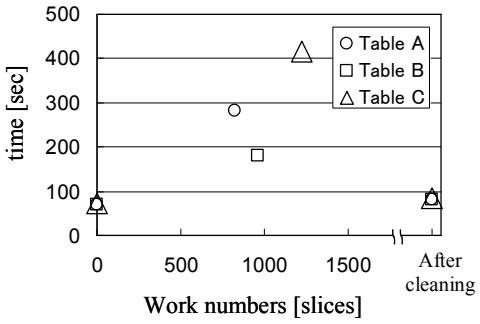

Figure11. Water transit time

ACKNOWLEDGEMENTS

The authors would like to thank SCK Manufacturing Engineering Department member designed water recycling system and also thank Safety & Environment Section member supplied company green activity data.

ACRONYMS

MMIC: Monolithic Microwave Integrated Circuit
SCK: Sony Semiconductor Kyushu
GaAs: Gallium Arsenide
IPA: Isopropyl Alcohol
PC: Personal Computer
LNG: Liquefied Natural Gas
MF: Microfiltration