레이저충격파를이용한웨이퍼세정

(Wafer cleaning efficiency by Laser Shock Wave)

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ABSTRACT

To develop cleaning process various particles should be deposited on wafer surfaces to measure particle removal efficiencies. The purpose of the article in to evaluate, removal efficiency of silica and alumina particles from wafer surfaces when they are deposited by dry and wet method. Dry deposition in air and wet spray deposition using solutions are used. van der Waals are considered to calculate the adhesion force of particles on surfaces. Higher adhesion force is measured on alumina particles on silicon when particles are deposited in air.

INTRODUCTION

In semiconductor manufacturing, wafer surface cleaning is one of the most important processes as the integration density of device increases and the higher yield without production loss is required. A well-know RCA wet cleaning chemistry has been applied in the semiconductor manufacturing conventionally.

The cleaning wafers, particles are one of most critical contaminants to be removed from wafer surfaces. The particles exist in liquid or in dry form before the deposition. Most commonly practiced deposition method is air-sol spray method using air gun. Particles should in suspended in liquid to be sprayed on wafer. Even though particle removal mainly depends on its property, the deposition method could affect the cleaning efficient results. Dry deposition and wet spray deposition using IPA and DI water were applied. In this paper, effective of particle deposition methods on its removal efficiencies from wafer surfaces[1].

EXPERIMENTAL PROCEDURE

A 4 and 6″ p-type (100) bare silicon and TEOS (Tetraethylorthosilicate) glass deposited are used for the study. These wafers are contaminated with fumed silica particles of 1㎛ in diameterand alumina particles of 1㎛in diameter. Theses particles are deposited by two different methods. Dry deposition is performed by passing through wafer in to the chamber which dry particles are dispersed in air by N2 spray on surface with particles. When the intense laser beam is focused the wafer surface, the gaseous constituents began to breakdown, so the gas ionized and heated, producing a plasma shock wave. The shock wave propagates to the particles and the substrate. If the force of shock wave is larger than the adhesion force between the particle and the substrate, the particles began to remove from the surface. Surfscan 5500 (KAL-Tencor) is used to measure the number of particles on wafer surfaces. In order to observe the magnitude of adhesion force of particles on surfaces, a physical remove force, is applied to particles was shown in Fig 1[2].

RESULTS AND DISCUSSION

When particles are spray deposited from liquid, one of major interactions is capillary reaction between particle and substrate. In order to understand the capillary effect between particle and wafer surface, the adhesion force of particle is calculated in termsof van der Waals force and capillary force. van der Waals force is described as following equation (1) considering the deformation of particles[3]

$$F_r = \frac{Ar}{6Z^2} + \frac{Ar_c^2}{6Z^3} \tag{1}$$

where A is the Hamaker constant, r is the particle radius, rc is the radius of the contact surface area, and Z is the atomic separation between the substrate and the particle. Deformation of particles is introduced in Equation (1) by assuming r_c as 3% of r[ ]. On the other hand, the capillary force can be described as shown in equation (2) [4]

Figure 2 shows van der Waals adhesion force of alumina and silica particles on silicon and TEOS wafers as a function of there size. Alumina particles show higher adhesion force than silica particles. Adhesion force on silica is higher than that on TEOS surface due to higher Hamaker constant of silicon.

Figure 3 shows the removal efficiencies of during deposited alumina and silica particles on silicon and TEOS wafer by laser shock cleaning. Alumina particles are harder to remove then silica particles on both silicon and TEOS wafers. The removal efficiencies of alumina particles on silicon and TEOS wafers are 87% and 91% respectively. Silica particles showed higher removal efficiencies of 95% and 97% on silicon and TEOS wafer, respectively.

CONCLUSIONS

The effect of deposition method on particle removal efficiencies is stud, dry deposition of particles are performed on silicon and TEOS wafers. van der Waals force is dominant in dry deposited particles on surface. Laser Shock Wave Cleaning is applied to remove dry deposited particles at a set condition dry deposited particles are removed over 90% removal efficiency.

REFERENCES

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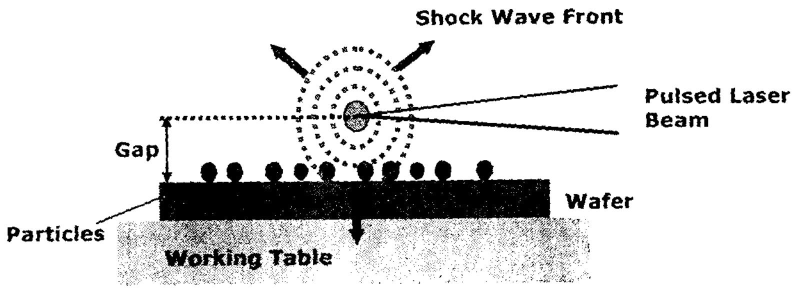
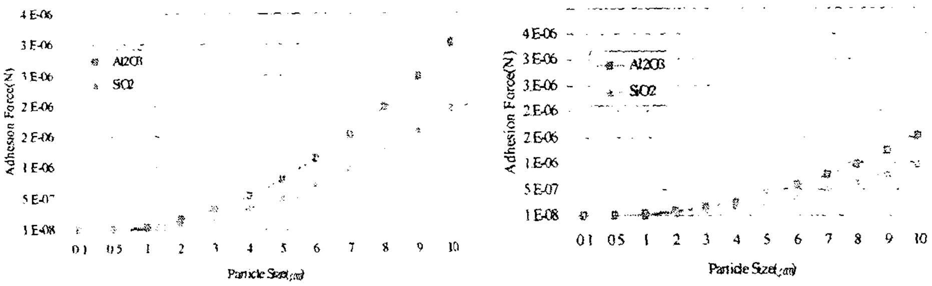


Figure 1. A schematic diagram of the laser shock cleaning (LSC) mechanism



(a) (b)

Figure 2. (a) van der Waals a adhesion force on silicon and (b) TEOS wafer as a function of particle size

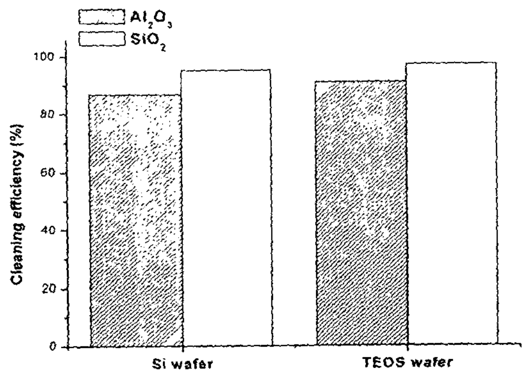


Figure 3. The cleaning efficiency of Al_2O_3 and SiO_2 particles when particles are dry deposited on the Si and TEOS wafer