[The new method developed by the correlation method of monitoring minute particles in space -Toshiaki Tanaka]

[R.Katayama/H.Kubota/K.Yoshinaga]
[t_tanaka@st.cs.kumamoto-u.ac.jp – c2740@st.cs.kumamoto-u.ac.jp]
[Graduate School of Science and Technology Kumamoto University.]
[2-39-1 Kurokami, Kumamoto, 860-8555 JAPAN]
Phone: +[81] -[96-342-3035] Fax: +[81]-[96-342-3065]

Background

With the miniaturization and high integration of semiconductor devices, the size of the particles causes a fault has been miniaturized year after year. It is difficult to be eliminated that the particle becomes minute and becomes strong in an adsorption power under the influence of an intermolecular force and static electricity.

In order to prevent the adhesion of particles, it is important not to suspended particles in the clean room, to make such an environment it is necessary to grasp the flow of air flow in the clean room. Currently, the heat-type anemometer is generally used for a current of air measurement. However, the heat-type anemometer takes a considerable time for the calculation of the airflow distribution because the thermal anemometer is a fixed point measurement. Also, it can not even measure the wind direction. Therefore, extensive collective current of air measurement technique is demanded not a fixed point.

Principle

In the analysis of this study, we use fluorescence correlation spectroscopy. Fluorescence correlation spectroscopy, when molecules go in and out of a confocal small domain by a diffusion campaign, intensity of fluorescence shakes by reflecting the diffusive speed.

I calculate the autocorrelation function of standardized intensity of fluorescence and evaluate the speed of the fluctuation by a fitting does a theory type. I in this way find a molecular number. In this article, I examine having relations or not between the signal by evaluating the similar degree of two chronological order signals.

Evaluates a change of the scattered light intensity at plural positions, and measures the direction of the wind and the wind velocity by taking the cross-correlation of scattered light intensity detected in each between domains divided at a correct interval.

Experimental methodology

Show experiment environment in Fig.1 and show the division method of the detection domain by this experiment in Fig.2. By this technique, we measure scattered light intensity with a CCD camera and a xenon flash lamp. We irradiate a particle drifting all over the space with the light of the xenon flash lamp and acquire scattered light intensity with a CCD camera from the place to be located at 90 degrees of the xenon flash lamp. On this occasion, synchronize a CCD camera and Xenon flash lamp using a function generator. By this experiment, we cut the data which we photographed with a CCD camera at the center of length and the width, and calculate a correlation curve when we supposed that a particle flowed from measurement range A through B and it flowed from measurement range B through A. It is determined which direction a particle flows through from peak value of the correlation curve. Then, we test it equally about measurement range C and measurement range D. One pixel of photography data is 0.3869mm and is 40pixel long, wide 168pixel. The time when the correlation is the highest of the scattered light intensity is delay time τ. Here, it is considered to have moved a distance to the center of the measurement range from the center of the other measurement range by applying the τ delay, and calculates the moving speed of the particles.

Results and discussion

Show a correlation curve calculation result in the case when it is supposed that the particles have moved in each direction in Fig.3-6. By the result, the correlation curve of Fig.4 and Fig.5 shows the high peak value, and Fig.3 and Fig.7 became the decrement graph. By the result, it is thought that the particles moves from measurement range B to measurement range A for 0.0333~0.0666[s], and it moves from measurement range C to measurement range D for 0.0333[s]. If a particle does not really flow through the direction that supposed a particle flows, there is not delay time getting correlation, and correlation graph is with a decrement curve. We perform three times of same experiments and show the result in Table.1. In all three times of result of a measurement, they calculate the particle velocity in the true value. Unevenness occurs in the true value, but this is because the speed of the wind is not really constant.

Summary

In this study showed effectiveness of the method of measuring the velocity and direction of the particles using a correlation method from the scattering intensity of particles in a clean room. Because some unevenness produces the irradiation optical power of the xenon flash lamp by a coordinate, even the same particle may greatly give off different scattered light intensity. Because we take correlation of the scattered light intensity in this experiment, it is thought that the unevenness of the irradiation optical power leads to a measurement error. For the future, equalization of the irradiation optical power is a problem.

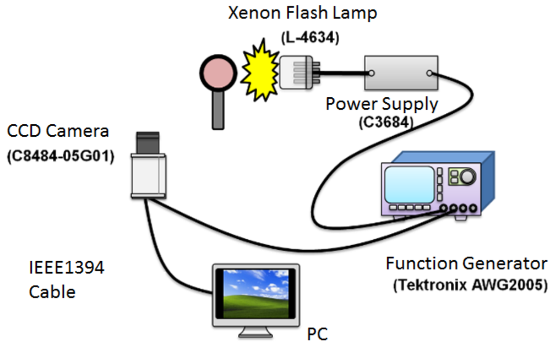

Fig.1: Experimental Environment Figure

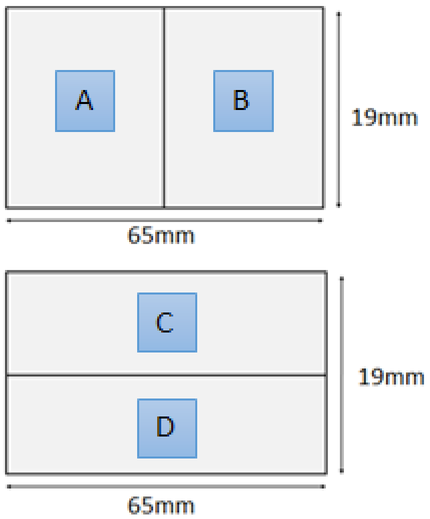

Fig.2: Split-screen view of a photographic data

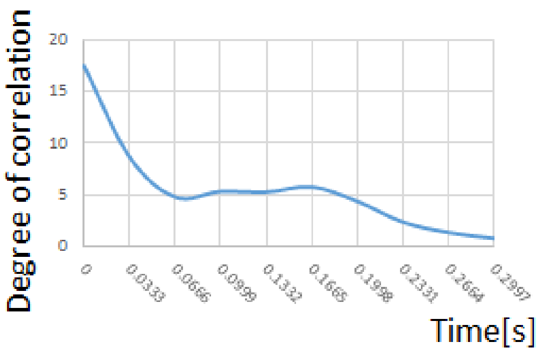

Fig.3: Correlation curve from the detection area A to B.

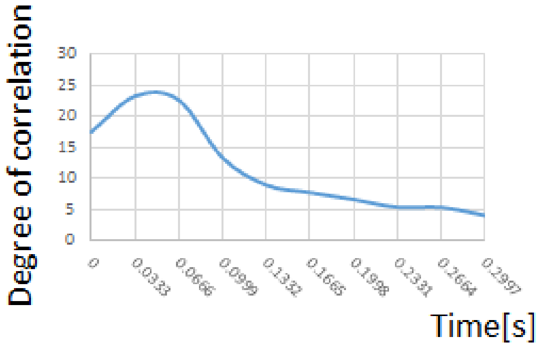

Fig.4: Correlation curve from the detection area B to A.

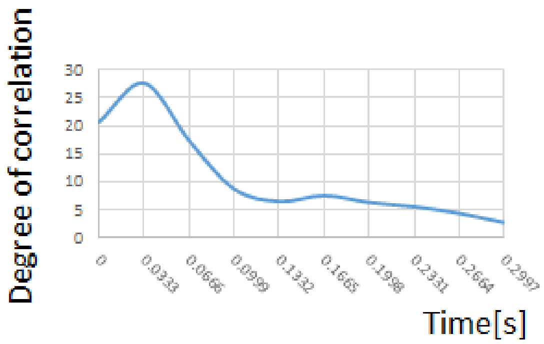

Fig.5: Correlation curve from the detection area C to D .

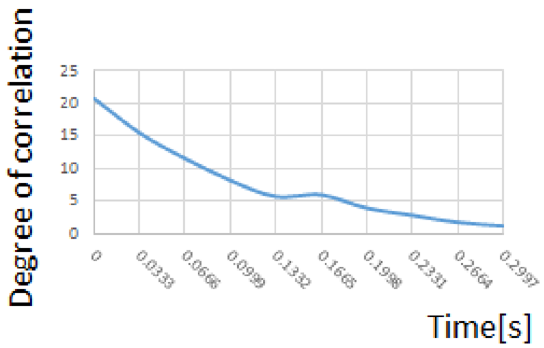

Fig.6: Correlation curve from the detection area D to C.

Table.1 : Comparison with the result of performing the same experiment three times and the true value

	Experiment.1	Experiment.2	Experiment.3
Actual true value（Direction B to A）	46.5~123.2cm/s	46.5~123.2cm/s	46.5~123.2cm/s
Grain speed estimate by the correlation method	97.6cm/s	48.8cm/s	65cm/s
Actual true value（Direction C to D）	47.6~67.4cm/s	47.6~67.4cm/s	47.6~67.4cm/s
Grain speed estimate by the correlation method	56.9cm/s	56.9cm/s	56.9cm/s