CMP slurry stability

Effect of polymer molecular weight

Application
Electronic

Objective
Monitor the effect of polymer molecular weight on CMP slurry stability

Device
TURBISCAN® LAB

INTRODUCTION
Chemical-mechanical polishing (CMP), is a technique used in semiconductor fabrication for planarizing a wafer or other substrates. This removes material and tends to even out any irregular topography, making the wafer flat or planar at the Angstrom level.
Cerium(IV) oxide, also known as ceria, is an oxide of the rare earth metal cerium. It is known to have a high polishing efficiency for oxide film, but also it has an unfavourable reputation for problems linked to its quick sedimentation and agglomeration of particles, which can alter significantly the CMP process, leaving unwanted defects. Therefore it is necessary to tailor the ceria slurry in order to reach the right stability requirements for CMP applications.
Polymeric dispersants are typically used to stabilise ceria particles, *via* steric stabilisation. Hence, the molecular weight of the dispersant plays a key role in the stability efficiency.

METHOD
We analyse three suspensions of ceria using the Turbiscan LAB at 35°C for 12 hours. Formulation A contains high, formulation B intermediate and formulation C low molecular weight of dispersant.

RESULTS
1. Identification of instability mechanism

All three formulations display a similar behaviour (Figure 1) with:
- a decrease of the backscattering signal at the top as the particles deplete from this region due to a sedimentation process.
- Simultaneously backscattering increases at the bottom of the vial, where the particles settle.
- Transmission increases at the top when clarification is large enough for light to cross the suspension. This would be eventually visible to naked eye observation.

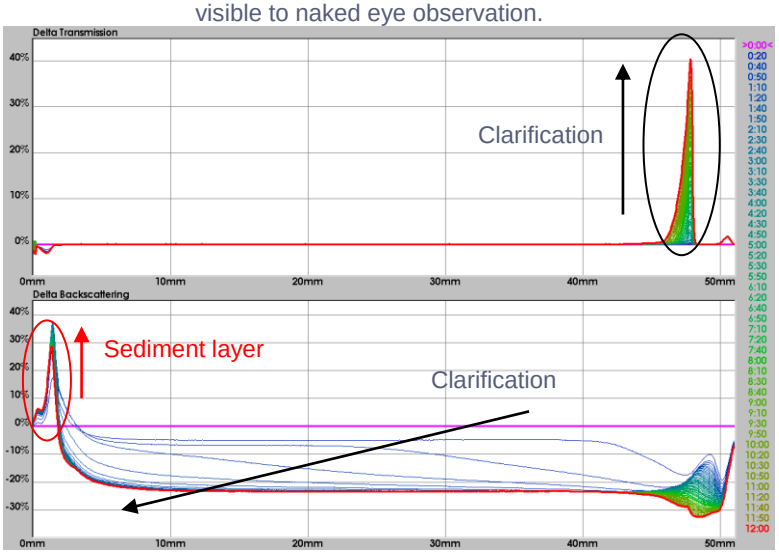

Figure 1. Delta transmission (top) and delta backscattering (bottom) for Ceria suspension A at 35°C.

2. Sample comparison

In order to compare the extent of sedimentation in the three formulations; it is possible to compute the speed of clarification (table 1) from the slope of the thickness of the clarified layer (Figure 2).

Table 1. Thickness of the clarified layer after 8 hours of analysis and clarification velocity of the three ceria suspensions

Sample	Thickness layer after 8 hours (mm)	Clarification velocity (mm/h)
A	0.29	0.17
B	29.20	2.34
C	46.00	13.87

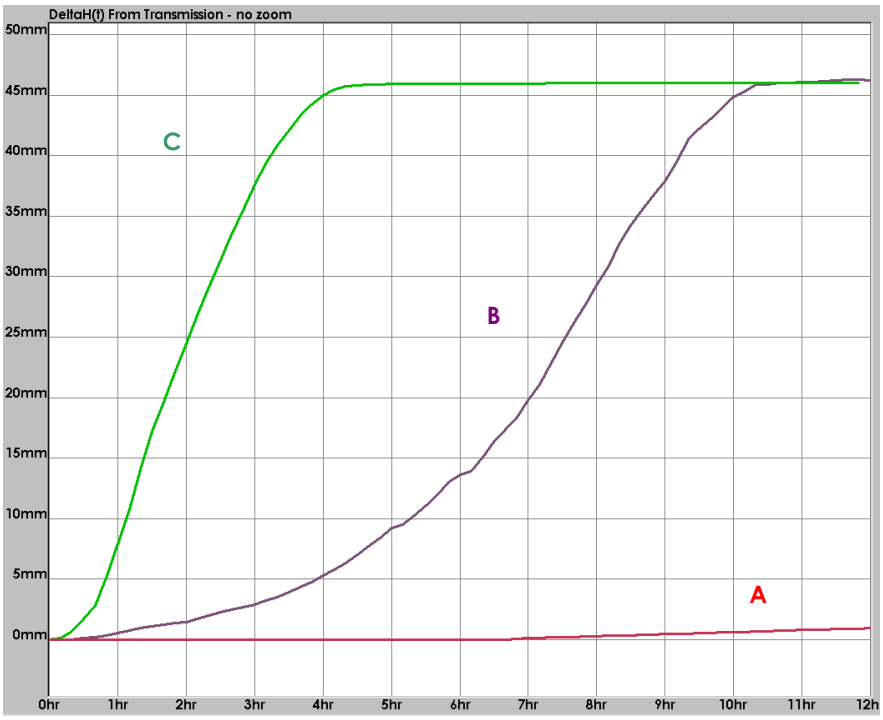

Figure 2. Thickness of clarified layer for the three ceria suspensions.

These results enable to show that at 35°C, it is possible to classify the stability against sedimentation of the ceria suspensions in a few hours. Formulation A displays the best stability and formulations C the worst. This highlights the effect of the molecular weight of polymer dispersant, where long polymer chains give rise to better steric repulsion, hence better stability.

SUMMARY

The Turbiscan LAB enables to determine the instability mechanism and quantify the effect of polymer molecular weight on CMP slurry stability.