



Evaluation for In-Plane Micro-Deformation Distribution Characteristics of Polishing Pad Surface



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Objective

To investigate the polishing pad surface texture using a digital image correlation (DIC) method for stabilizing polishing performance.

Back grounds

- ! In the polishing process, polishing performance demand on status of consumable materials.
- ! Polishing characteristic is affected by *pad water-containing*, *pad surface profile* and *pad surface asperity*.
- There is a compelling need for performance evaluation of pad to stabilize polishing performance.

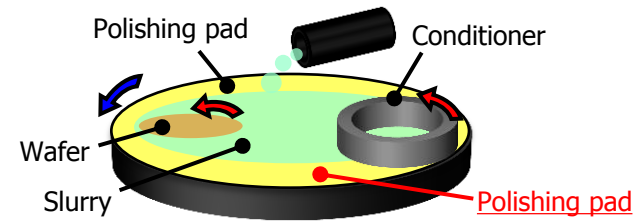


Fig. 1 General description of DIC

In this study

- ◎ Pad shrinking characteristics
- ◎ Relationship between the in-plane micro-deformation distribution characteristics of pad surface texture and pad cutting amount in the conditioning process

General description of DIC

◎ DIC(digital image correlation) can measure the full-field deformation distribution in the photographed image obtained by digital camera.

Procedure for DIC

- 1 Take a *original image* of measuring object (in this study, polishing pad) with digital camera.
- 2 Take a *comparison image* in the same area as the original image.
- 3 Calculate In-plane deformation using DIC with original image and comparison image.

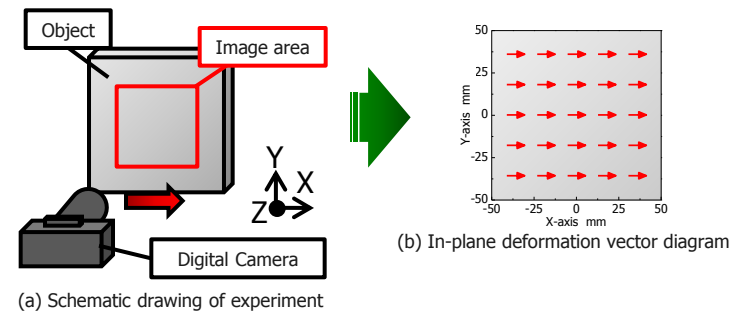


Fig. 2 General description of DIC

Pad shrinking characteristics

We observe *shrinking characteristic* of 3 kind of pad by DIC.

- All of the pads *shrink toward center of the pad*.
- *Groove of the pad* and *Hardness of the pad* have an affect on shrinking characteristic.

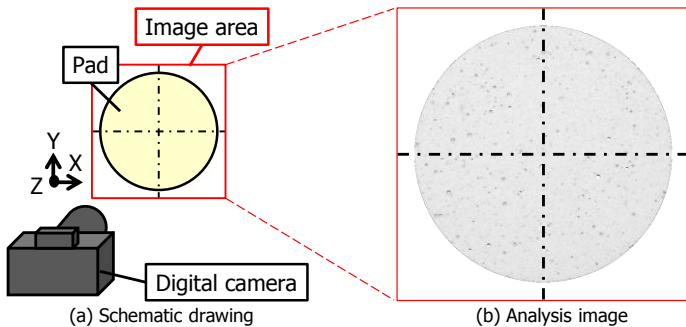


Fig. 3 Experimental outline of shrinking characteristics

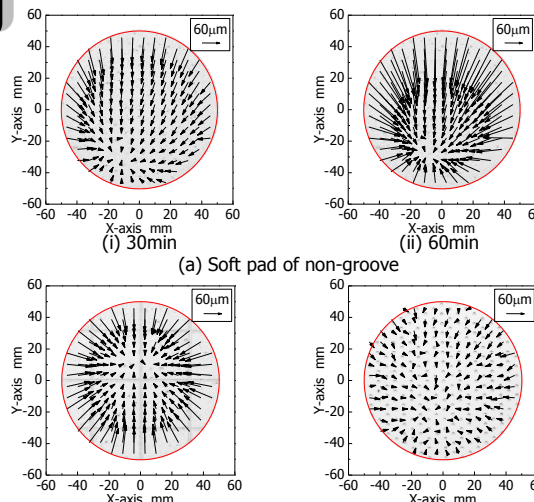


Fig. 4 Pad shrinking characteristics

Table I. Experimental parameters of shrinking characteristics

Pad	Soft pad (Non-groove, XY-groove)	Hard pad (Perforation)
Diameter of pad	100 mm	100 mm
Measurement time	15, 30, 45, 60 min	15, 30, 45, 60 min
Image size	120 mm × 120 mm	120 mm × 120 mm
Subset size	151 pixel	151 pixel
Distance of scan step	20 pixel	20 pixel
Size of 1pixel	50.7 μm/pixel	50.7 μm/pixel

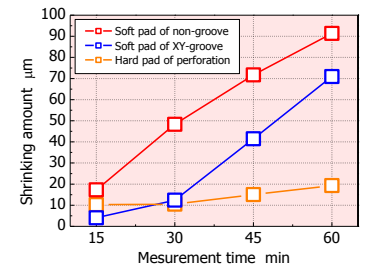


Fig. 5 Relationship between measurement time and shrinking amount

Relationship between in-plane micro-deformation distribution characteristics of pad surface texture and pad cutting amount in the conditioning process

We observe ◎ *in-plane micro-deformation distribution characteristics of pad surface texture*.
◎ *pad cutting amount*.

- There is a high correlation between *in-plane micro-deformation value* and *pad cutting amount*.

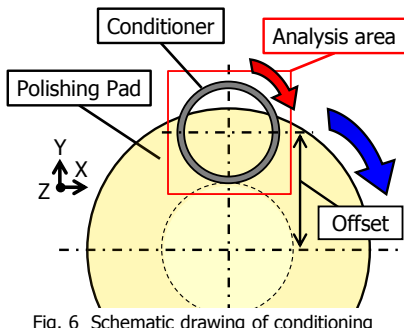


Fig. 6 Schematic drawing of conditioning

Table II. Experimental parameters of conditioning experiment

Pad	Soft pad (Non-groove)
Image size	120 mm × 120 mm
Subset size	151 pixel
Distance of scan step	20 pixel
Size of 1pixel	59.7 μm/pixel
Mesh size of conditioner grains	#80
Conditioning time	60 min
Conditioning pressure	15 kPa (150 gf/cm ²)
Diameter of platen	290 mm
Outer/ Inter diameter of conditioner	100 mm/ 82 mm
Offset of conditioner	125 mm
Rotation speed of conditioner	1/30 s ⁻¹ (2 rpm, CW)
Rotation speed of platen	1/2 s ⁻¹ (30 rpm, CW)

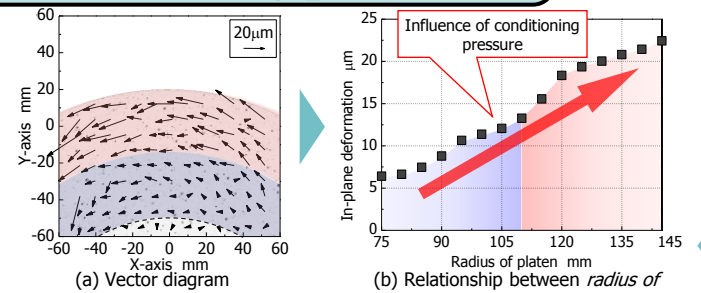


Fig. 7 Pad in-plane deformation by DIC

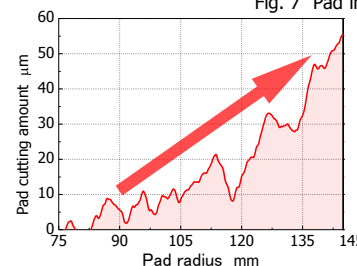


Fig. 8 Relationship between radius of platen and pad cutting amount

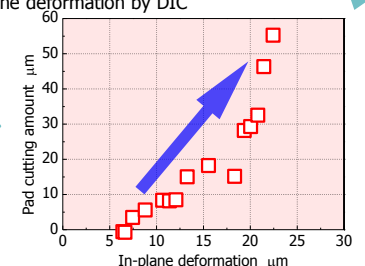


Fig. 9 Relationship between in-plane deformation and pad cutting amount

Conclusions

- ◎ The shrinking amount of the pad is proportional to time.
- ◎ Shrinking amount of a soft pad is larger than that of a hard pad.
- ◎ There is a high correlation between *in-plane micro-deformation characteristics* and *pad cutting amount*.