Diamond turning of RDDSI disks

Contents:

1 .Detailed description of fabrication of RDDSI disks.

2.Some issues remained to be studied.

Procedure for RDDS1 disks machining

1. Rough machining

Makes blanks from copper bar by band saw.

Turning with over size of 40 μm .

Grinding both sides.

Make one of them as a datum.

Improvement of flatness .

Milling to final dimension.

2. Annealling

Purpose is stress releasing.

Vacuum at 500°C for 2 hours.

3. Hand lapping of one side

Purpose is removing scratches.

At #800 sandpaper on the optical flat.

Time is about 30 seconds for 1 disk.

(Time was reduced by Grinding)

4. Intermediate turning

5. Final turning

Intermediate turning

Functions of intermediate turning

1. Reduce the tool damage at final turning.
2. Improvement of flatness.

Cutting condition

Cutting with over size of 10 ,um.

Rotation speed	2800rpm
Cutting speed	40mm/min then 27mm/min
Cutting depth	6 μm
Tool	Single crystal diamond tool
Chuck	Vacuum chuck
Process time	-1 5min/1 disk

Final turning

Processes in Final turning

O.Measrement of tool radius.

1.Daily process

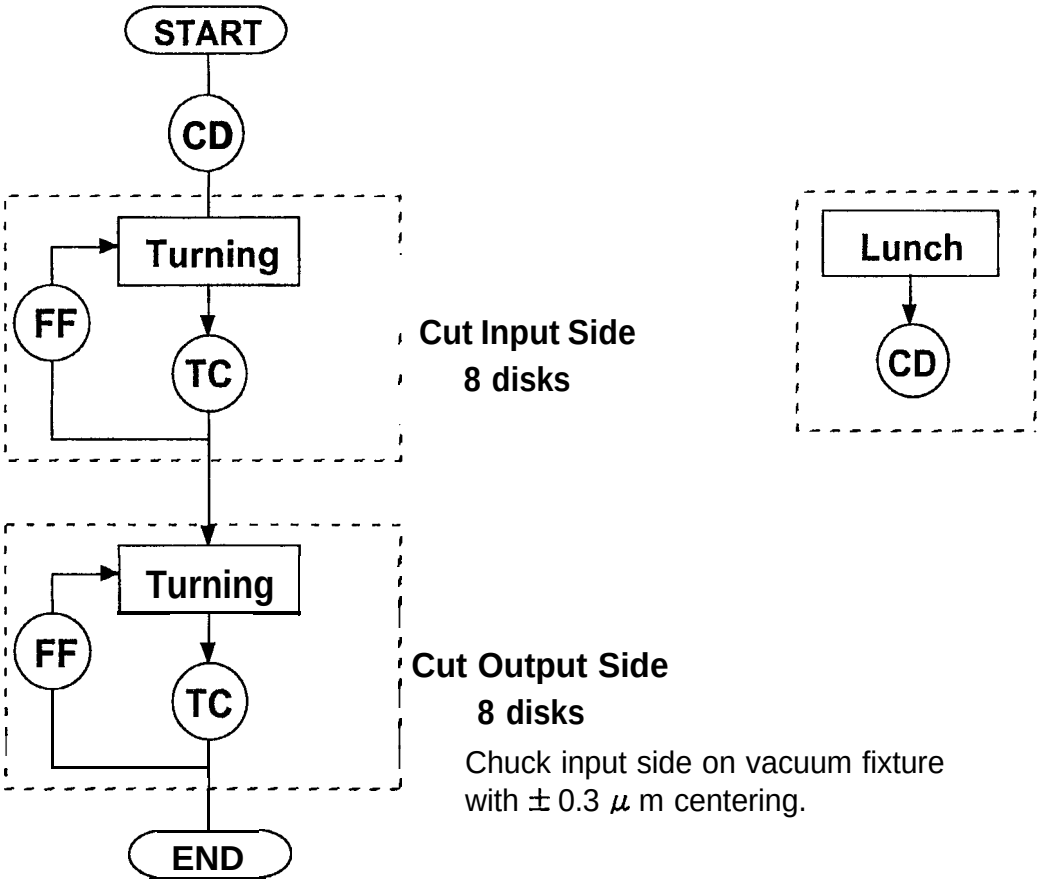
2.Based on RF measurement of previously machined disks,"2b" dimensions can be modified for the fabrication of later days.

3.After fabrication of all disks, flatness and thickness of all of the disks were measured.

Cutting condition

Rotation speed	2800rpm
Cutting speed	40mm/min then 27mm/min (3mm/min at cavity area)
Cutting depth	4 μm + 4 μm+ 2 μm
Tool	Single crystal diamond tool
Chuck	Vacuum Chuck
Process time	~30min/1 disk

Typical turning process in a day



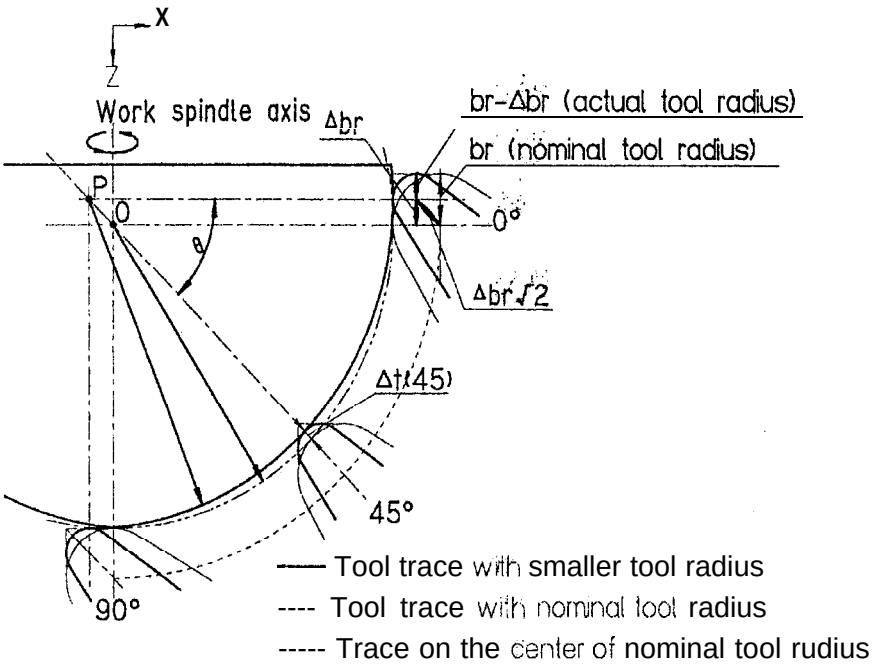
CD : Cut dummy disks measure “OD” adjust tool position.

FF : Temperature of the previous disk just after cutting was input to NC for the following disk,if changed a lot.

Check “OD” just after cutting .
If it indicates a drift to run over 0.75 μ m, the tool positioning reference in radial direction was changed.

TC : Checking diamond tool by microscope.

Evaluation of diamond tool radius



Position error (θ =45°)

$$\Delta t(45)=\Delta br(\sqrt{2}-1) \quad (1)$$

The maximum separation between these two lines is related to error of tool radius " A br" as shown (I)

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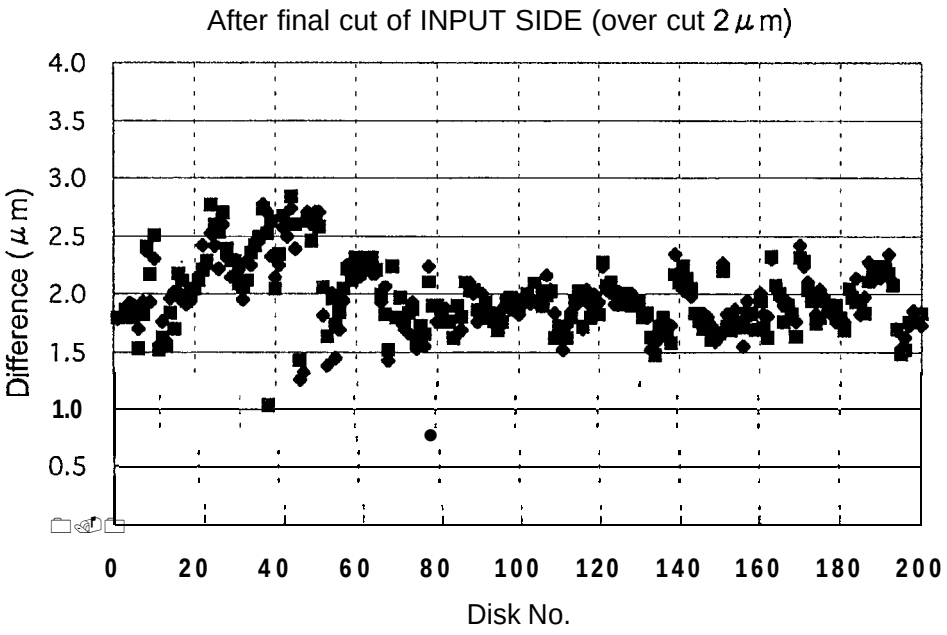
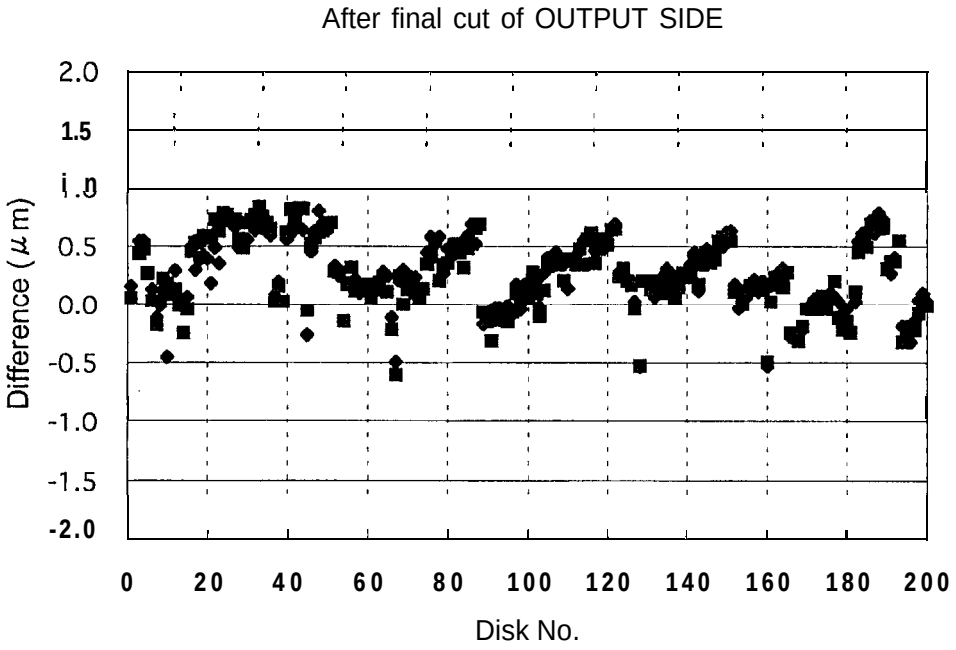
Measurement of OD





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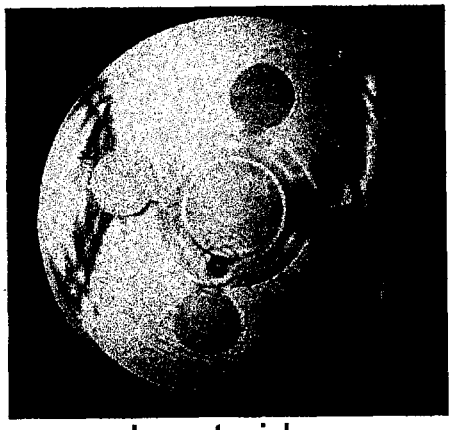
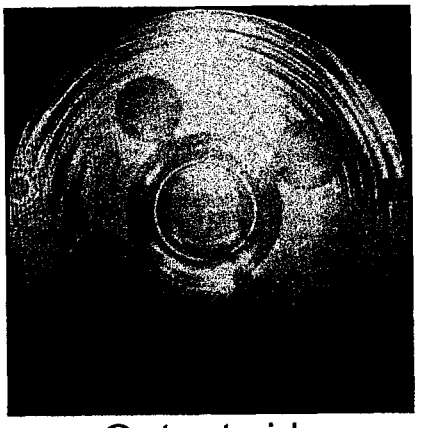
Flatness of disks

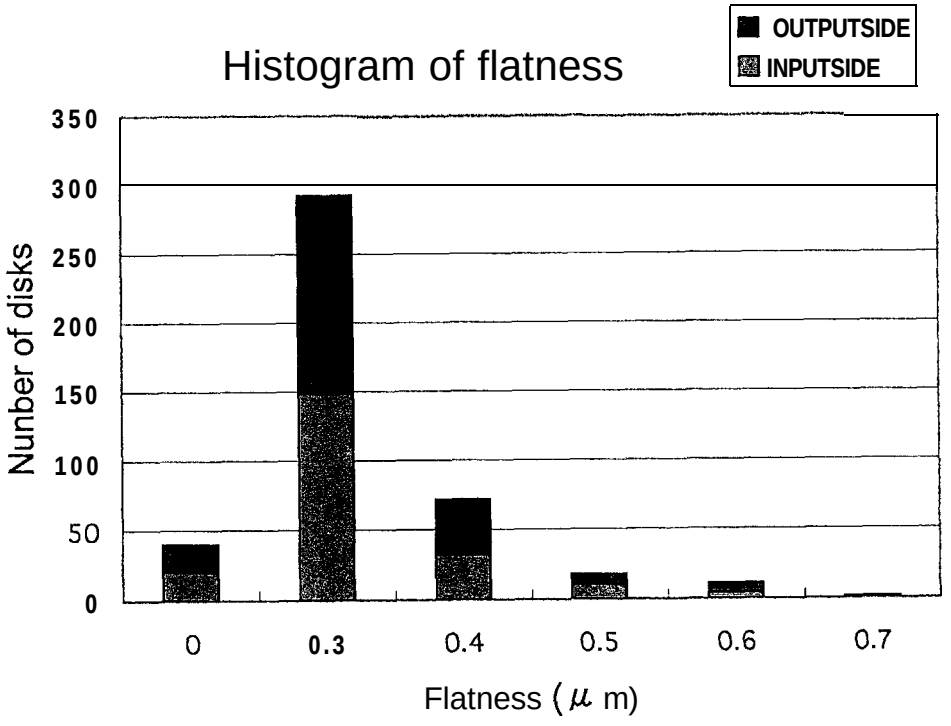
Typical intetferogram pattern



Input side



Output side



Some issues remained to be studied.

1. Parallelism

Some of the disks were out of tolerance.

Need more study

2. Concentricity error

Some of disks showed 2 μ m concentricity.

Need more study

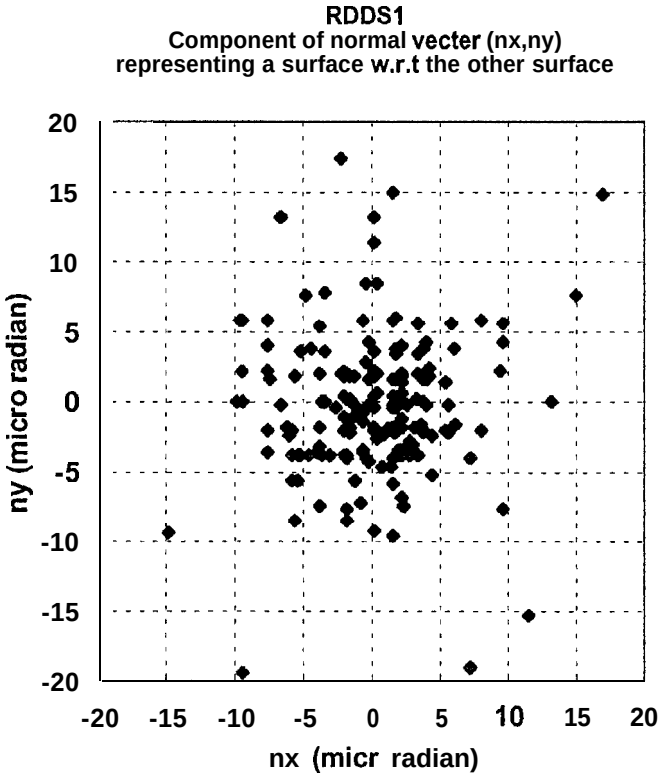
3. Tool wear

We need to understand the mechanism of the tool wear.

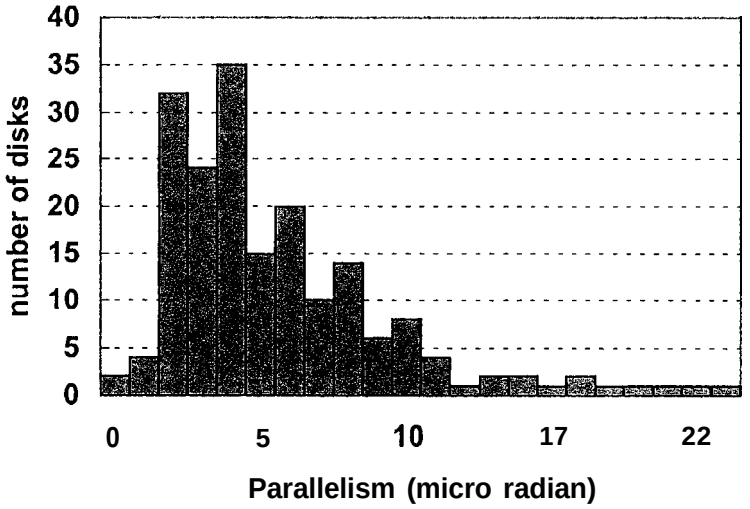
1. Intermittent cutting due to alignment notch.
2. Cutting of corner where rough machining stage surface remains.

Need more study

Parallelism of standard disks

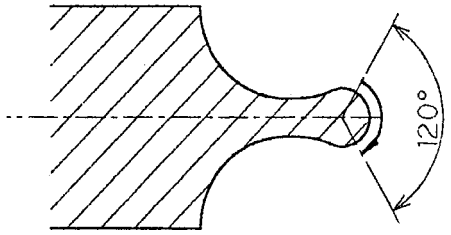


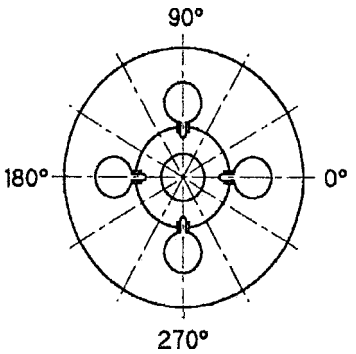
Histogram of parallelism



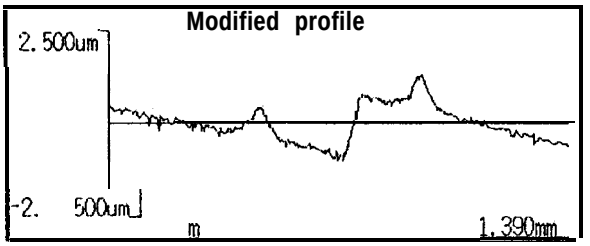
Some of the disks were out of tolerance

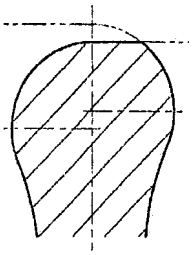
Concentricity measurement



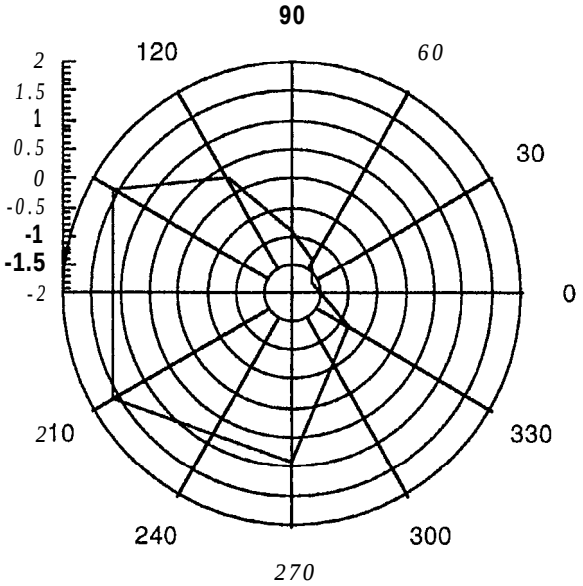


Residual from circular fitting
(Measurement by Form Talysurf)

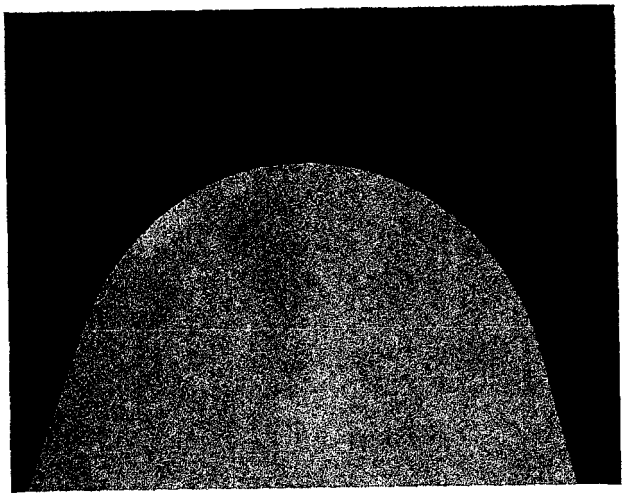




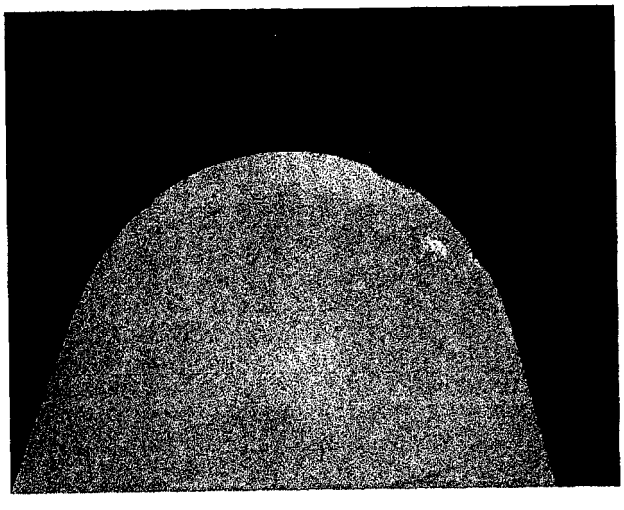
Angular distribution of the step



Cutting edges of diamond tools

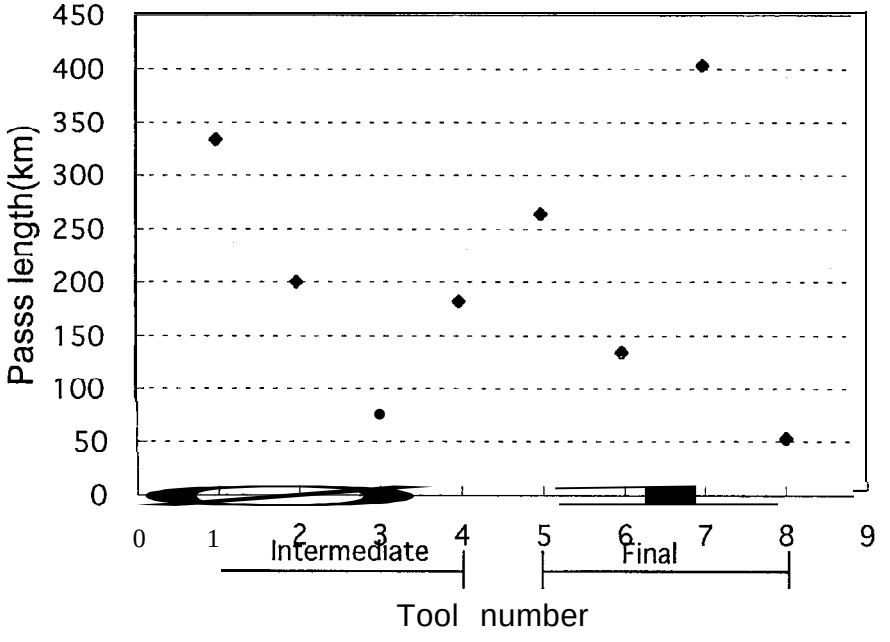


New tool



Tool wear

Total pass length of each tool for fabrication of all RDDS1 disks



Future subject

1 .Production of disks for prototype is established.

2.Some issues such as parallelcity and concenticity should.

3.Studies toward longer tool life should be performed.

4.Reducing the time for cutting process should be studied.