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I-stepper
STANDARD OPERATING PROCEDURE
CORAL Name: i-stepper
Model Number: Nikon NSR2005i9
Location: ICL
What it does: Wafer stepper
Introduction: The ICL i-stepper is a machine that transfers mask circuit patterns photographically onto existing patterns on 6" silicon wafers with high resolution and great positional and overlay accuracy.
The i-stepper uses I-line UV illumination (365 nm Hg spectral peak) to expose mask images in a photosensitive film that coats the wafers. The system aligns the wafer and prints each frame as an X-Y stage positions the wafer beneath a fixed lens column.
The image that is printed is a 5x reduction of the mask (reticle) design and can be aligned to an existing wafer pattern to within 50 nm accuracy and with a limit of resolution of around 0.5 um. The image field size can be adjusted from the full frame 22.0 mm down to 2.5 mm and this smaller image can be placed anywhere within the field.

The wafer stage is controlled by a laser interferometer system which measures its X-Y position relative to the lens optical column. Nikon's LSA wafer alignment method utilizes this positioning system to calculate deviation from the ideal position as defined in a process program and corrects wafer placement. The wafer stage also corrects wafer rotational error, (as detected by the LSA alignment system), corrects wafer leveling, and moves the wafer in the Z axis to maintain focal distance to the lens as part of it's auto-focus system. The i-stepper is housed inside a chamber to provide environmental and vibration isolation. User access is provided by a control console with keyboard/crt /joystick interface to the MCS II system software. Overall system control is managed by a DEC PDP-11 computer.

The stepper user creates and executes process programs which contain information about the reticle, wafer and exposure parameters, alignmnent marks and stepping configuration. Different program directories are maintained for separate engineering, maintenance and operation functions.

All operations are executed through MCSII commands. These commands are listed in the form of menus, the primary one being the NSR Command Menu. The "process program" is the job or file that is being executed. Process programs are stored in directories, typically by type or by user.

Safety: Safety glasses are required at all times in the lab. Do not attempt to view the exposure process. The UV illumination and the presence of measurement lasers are not healthy for your vision.
Keep your hands free of the wafer transfer mechanisms. Do not attempt to remove a wafer or reticle from the machine by hand.

Procedure: Check the Schedule Menu in CAFE to confirm your reservations.

Open an "Operate Machine" entry from the Fabrication Tools menu choice.
Typical log entries pertain to number of wafers, exposure time and focus values.

Place your coated 6" wafers on the left cassette indexer.

At the console choose Command Menu #3 - Execute Program. The system will prompt you for the program name.
Your process program must be created and placed in the "entry list" buffer prior to job execution. This procedure contains the information needed to create/edit a process program file.

Enter your process program name <cr>. The system will bring up the reticle page.

In the Operation field (upper right) choose CHANGE and enter the slot number
of your reticle in the slot field. Press PF1 and confirm Go to execute reticle loading.
Reticle loading/alignment will take 2 minutes. If a reticle was left on the
reticle stage, this change command will return it to it's cassette in the library.

Press PF2. This will present options in the form of a "spot menu". Choose Exposure
to enter the following parameters:
o number of wafers o method of exposure
o exposure time o focus offset

There are two basic methods of exposure: the Normal mode, where exposure time
and focus offset are fixed and the Test mode where these parameters are varied.
This Test method is a common way to determine daily best focus/dose settings.

Press PF1 and confirm Go to execute the job. No other intervention by the user is
necessary, unless one choose to perform alignment in manual mode.

Wafer are returned to their position in the cassette when exposure is completed.

Close your "Operate Machine" window in CAFE.

NSR Command Menu (1) ENTER process program(8) REMOVE
       wafer & reticle
       (2) READY process(9) SHOW status
       (3) EXECUTE process(10) CALIBRATE machine
       (4) CONTINUE process(11) ADJUST machine
       (5) RESERVE reticle(12) EDIT process data file
       (6) CANCEL reserved reticle(13) ASSIGN reticle
       (7) EXAMINE reticle

Processing and exposing a wafer uses four main commands which
access specifications about the job to be processed and
control the subsystems needed to execute it. They are:
(1) ENTER process program. This command manages all of the
process programs and allows the user to load a job from the
hard drive into a buffer called the Process Program Entry
List. The ENTER command presents it's own "Main Menu" choices
that allow the user to select a job from the entry list and
elevate it to "current process program"
(2) READY process. This command executes reticle operations
such as load, alignment and unload of the reticle that is
specified in the current process program.
(3) EXECUTE process. Performs both reticle and wafer
processing operations with information found in the process
program.

(4) CONTINUE process. This command allows one to resume
processing with additional wafers using the same program and
the same reticle. Can be used only after EXECUTE command has
completed successfully. The advantage here is that the reticle
does not need to be realigned.

Keyboard entry of commands and navigation through the many
screens of information is made easier by the externsive use of
the four function keys above the number pad. PF1 is the
primary execute key, PF2 is often used to access a "spot menu"
of options and PF3 and PF4 are used to facilitate travel to
previous and next pages. Their functions change but are
usually highlighted at the screen bottom line:
        PF1 : Command menu PF2 : Spot menu PF3 : Previous page
        PF4 : Next page

Alignment ENTER process program, load cassette of
        wafers.
        Select and load a reticle from the library.
        The alignment system positions the reticle such that its
        q - Y axis is parallel to the Y stage mirror.
        When completed, reticle position is measured against
        wafer stage (fiducial) position . LSA and FIA alignment
        systems establish their "baseline" positions at this
        time.
        Wafer orientation flat is found at pre-aligner.
        When processing a first layer, wafer fine alignment is
        not necessary and the wafer is stepped out.
        When a wafer is loaded onto the stage, auto-focus and
        leveling operations are performed.
        Next, Search alignment begins: the WY-q grating marks
        are scanned by LSA laser. Returned, diffracted light
        generates a waveform signal which is measured against
        stage position.
        The wafer theta stage removes any WY-Wq rotation. As
        with the reticle, this axis must be parallel to the
        interferometer system's Y-stage mirror.
        Finally, the WX global mark is found and wafer position
        is read into memory.
        The Enhanced Global Alignment (EGA) method takes several
        measurements and calculates shot
        positions correction values for X-Y offset, scaling,
        rotation, and X-Y othogonality. It then calculates
        an average correction value and, with it, determines the
        exposure position of every single xposure.
        The Die-by-Die (D/D) method performs X-Y measurement
        using the LSA or FIA systems and corrects positioning
        before using the LSA or FIA each exposure shot.

Creating a Process Program
A "process " is a group of programs that may be alike in some
way; by user, by product, substrate, device type etc. The
"program" is a member of the process family and it contains
all the information neccesary to align and step a wafer.
To create a new process program use Command Menu choice #12
Edit Process Data file. This brings you to a Process
Directory. Move to the appropriate box in the grid of

processes that is presented using the arrow keys, press
return.

This brings you to the "Define Process Name" screen. You are
in Create mode by default upon entering (the other mode is
Delete). Move to an empty field in the grid and type in a new
name. This opens the new file and presents five sections:

sections
1. WAFER BASIC data
2. RETICLE data
3. ALIGNMENT data
4. WAFER SHOT MAP data
5. WAFER EXPOSURE CONDITION data
You must specify values to fill in the fields provided in
these sections.
The PF keys facilitate movement within the file and the PF2
pops up the
section menu at any time. A check and save function exists as
well.
WAFER BASIC DATA:
Wafer size = 150 mm
Wafer shape = circle
Diameter = less than or equal to wafer size
Orientation flat = direction = Front, length = can vary
Step pitch in X and Y = center to center die spacing
Map Layout = number of shots in row and columns
Map Offset = moves whole map in X,Y to maximize shots on the
wafer.
Shot Offset = up to seven die offsets can be put in
RETICLE DATA:
Name = nam e of the reticle
Type = STD22
Check area independency = No
Check Area (mm) = particle check area , not used
Alignment adjust (um) = specify adjustment value in X, Y , q.
Pages 2-9 in this section give options for different reticle
blind settings.
ALIGNMENT DATA

Search = LSA, g-EGA = LSA or FIA, D/D = LSA or FIA or LIA
Search mark data
Mark position = Wy-q and Wx search mark positions within the
die (um).
Mark type , size, pitch, size tolerance, pitch tolerance.
= See reticle making SOP for recommended values.
Y-theta search sequence = Quick or Normal
Y-theta independency = No
Theta mark fix (63.5) = global Y to q distance during WGA
search
Vibration amplitude = 1
Signal gain select = generally Y = 1, and X = L11
Search mark choice = generally set to middle
Search processing algorithm = generally set to 1. See manual
for details
Search margins = generally set to 0.

g-EGA mark data

Mark position = LSA-x mark placement in X & Y, LSA-y
placement. (um)
Mark type, pitch = number of rows in LSA array, spacing of
rows.
Scanning times, steps = generally set to 1, 0
Mark profile = (0) concave or (1) convex, generally set to 1
Result allowance = generally set to 0.
Source signal = Mixed or Separate, generally set to Mixed
Processing algorithm = different methods of evaluating
waveforms, = 3.
Signal gain select = generally set to L22 for both X and Y.
Algorithm slice level = when processing algorithm(above) is
set to 3, use 20%.
Processing gate-A width = with Alg=3 use 8 um.
Processing gate-B width = use 0 with algorithm 3.
EGA reject, reject limit = set to No , 0 respectively.
EGA requisite shots = set to 0 , will sample 2 sites as a
minimum.
Multi-mark error mode = 0
D/D (die-by-die) mark data
Mark position = LSA-x, LSA-y mark placement. X & Y values, in
um.
Mark type, pitch = number of rows in LSA array, spacing of
rows.
Scanning times, steps = set to 1, 0 respectively.
Mark profile = use 1 , convex
Result allowance = set to 0 unless there are problems with
misalignment,
Source signal = Mixed or Separate, generally set to Mixed
Processing algorithm = different methods of evaluating
waveforms, = 3.
Signal gain select = manual is ambiguous, we set to L11.
Algorithm slice level = when processing algorithm(above) is
set to 3, use 20%.
Processing gate-A width = with Alg=3 use 8 um.
Processing gate-B width = use 0 with algorithm 3.
EGA reject, reject limit = set to No , 0 respectively.
EGA requisite shots = set to 0 , will sample 2 sites as a
minimum.
Multi-mark error mode = 0
WAFER SHOT MAP data
The shot map data screen gives a visual representation of
wafer defining
where the exposures are located for each of the different shot
catagories.
Exposure shots = are defined by an asteric in the appropriate
row/column.
Alignment shots = whether s-search, g-EGA or d- D/D.
Designated die
are the ones measured by the sensors.
Offset shots= as defined in Wafer Basic data page 2.
Blind Shots = as defined in Reticle Data pages 2-9
WAFER EXPOSURE CONDITION data
Exposure Method = Normal = all die shot with same focus, dose
values.
= Test1 = focus is fixed, exposure increases in a serpentine.
= Test2 = exposure varies across columns, focus by rows.

= Test3 = fixed exposure time, focus changes with each shot
= Test4 = exposure time changes by row, focus by column.
Exposure time (ms) = in Normal mode time is fixed, in
Test-mode this number
will be the center value and step will be the increment.
Focus (+/- um) = in Normal mode focus is fixed, in Test mode
this value
will be center and next value entered will be the step.
Alignment Method = 1ST used for 1st level exposure.
= EGA used for aligning to previous level.
= D/D for field by field alignment to previous level.
= Search for global align only, not fine alignment.
EGA path = generally g-EGA
Leveling Mode = set to No
EGA result usage = set to g-EGA for all:
Scaling-Orthog-Rotation-Offset
Correction fix = set to No for no

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