CHAPTER2 Automatic Evaporation Control System

2-1 Automatic Evaporation Control System ACS(Code No.M10-5146-0)------ 1set

2-2 MOP(Code No.M12-0001-0)------19p

OPERATION MANUAL
For
Automatic Evaporation Control System

ACS

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Table of Contents

Introduction

This manual contains important instructions for operating ACS.

Readers of this manual include those who:

- Engage in evaporation coating by operating ACS
- Manage evaporation data of ACS

Please read this manual carefully and fully understand the contents before using ACS of the coater machine.

For future use, keep this manual at hand.

Safety Precautions

Please read these precautions carefully before use.

WARNING!

Indicates that improper handling may cause fatal or serious injury to the person.

CAUTION!

Indicates that improper handling may cause injury to the person or damage to the property, including facility, other products, building, etc.

WARNING!

Be sure to turn OFF the power before inspecting the control panel and inside the chamber. It may result in an electric shock.

WARNING!

Never touch inside the control panel or inside the chamber. It may result in an electric shock.

Definition of Terms

Some of the terms frequently used in this document are explained as followed in this section.

Melting

The pre-processing of evaporation material before coating is called *melting*.

Evaporation

The process of thin film making through deposition.

EB

Electron beam gun.

RH

Resistance Heating (Heater)

IBS

Ion beam source.

GL (IBS)

Gridless ion beam source.

ACS

The automatic evaporation control software installed on the personal computer of coating machine..

Evaporation Process File (Excel format)

This is a file of Microsoft Excel format.
Containing all the necessary information for completing a coating process, the file is supplied to ACS for execution. It is usually characterized by batch and layer control parameters of a multi-layer optical film.

Melting Process File (Excel format)

This is a file of Microsoft Excel format.
It contains control parameters for pre-processing evaporation materials.

Process File

Referring to either Melting Process File or Evaporation Process File.

Melting Step

Changing EB emission from one value to another, and they holding it for a period of time are called one Melting Step. Melting Step is accompanied by other EB actions such as scan and position settings.

Melting Pattern

A number of Melting Steps formed a Melting Pattern.

Beam Rotation Pattern

A set of beam position set, when used usually formed a kind of circular movement of beam spot.

Beam Rotation Location

Referred to each of the beam spot position in Beam Rotation operation where electron beam works there for a short period of time.

HOM

Abbreviation for *High-Precision Optical Monitor*, which is the Optical Film Thickness Monitor developed by Optorun Co., Ltd.

Cup (or Hearth Cup)

Refer to one cup unit of a Cup-Type hearth.

PV

Abbreviation for *Present Value*

SV

Abbreviation for *Setting Value*

Notes for Text Styles

- Underlined terms

  This is used for components of a computer software user interface, such as a button, checkbox, up/down button, and so on.

  Example:

  FIL

  a button on ACS for tuning on EB's filament.

  Range

  a radio button on ACS for changing EB emission range.

- *Italic terms*

  Italic terms are used for special terminology related to ACS system or coating process in general.
  The following is a set of example:

  Rotation Speed:

  Specially referred the rotation speed of continuous type hearth.

  Primary Time Constant:

  Specially referred to one of the parameters used by crystal film thickness controller such as XTC/2 or IC/5.

Attention on using this document

This manual is NOT intended to be an equivalent of your machine's specification document. Some minute difference might exist between them, for example:

- This document shows that monitor glass is of 40-point, while yours is 60;

- This document presents a melting process with 20 cups, while your machine actually is mounted a 12-point hearth;
- Vacuum unit is displayed in *Pascal* (pa), while your current machine is in fact *percent* (%);
- Valid ranges of some of the parameters are not in accordance with those used in your machine.

If occasionally you catch a difference of this kind, please overlook it, and respect your machine's specifications.

This document serves you best as a general instruction for operation, and please do not take it as specification book.

Revision History

Rev. No.	Date	Content
Rev. 1.0	2007/04/	Initial Revision
Rev. 2.0	2010/04	Revised

1. Basic Operation

Get familiarized with basic operations prior to operating this system.

1.1 Startup and Shutdown of ACS system

1.1.1 Startup

- Computer Power On

  Please first turn on the computer.

  a. Turn on the power switch of both the computer and computer's display.
  b. After turning on the power, please follow the steps described in the following figures.

- Log on

  Please log on to the Windows OS.

  Note: this step can usually be skipped because special setting is made for automatically logon using default account.

- Start ACS

  ACS can be started by double-click the shortcut of ACSn Windows desktop.

1.1.2 Shutting down of ACS and computer

- Existing ACS

  ACS must be firstly exited before shutting down computer.

  a. On the main user-interface, press the *Exit* button. ACS will be exited.

- Shutdown computer

  Only after exiting ACS, can the computer be shutdown.

Note 1: Automatic shutdown of PC

If power off (of the whole coating machine) is detected when ACS is being executed, ACS will perform automatic shutdown of the computer.

1.2 Main User Interfaces

The following Fig. 1 is the main user interface of ACS, which is the one that immediately after starting up.

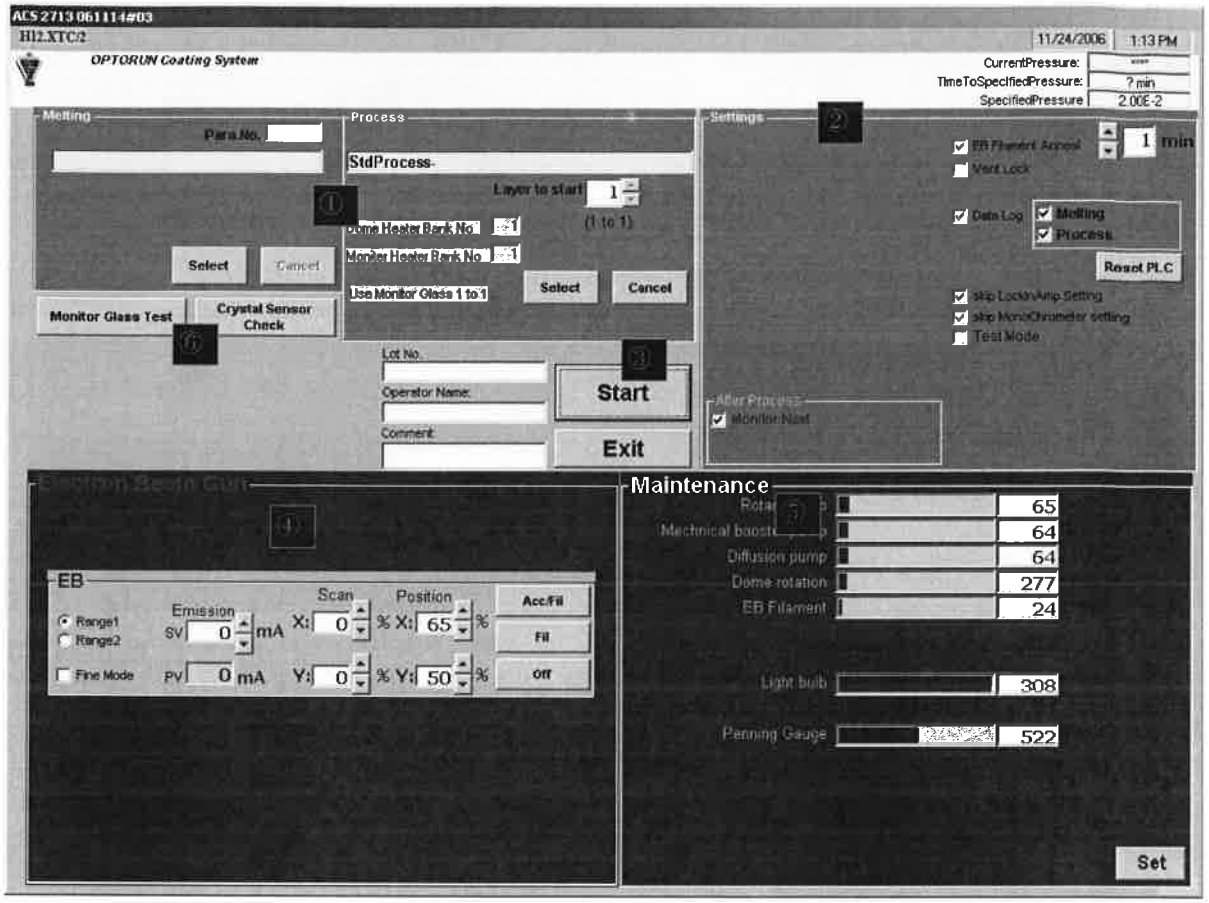


Fig. 1 Main User Interface

Description of the Main User Interface (Fig. 1):

1. File Selection Section
   Used for selecting Melting and/or Evaporation Process File.
2. Setting Section
   Offering various kinds of settings, usually applicable to the whole batch of coating.
3. Command Section
   Two commands: start and exit ACS.
4. EB Section
   For EB tuning.
5. Maintenance Section
   Display usage time of the short-life parts of the machine. Reset operation can also be done here.
6. Check Section
   Monitor Glass and Crystal sensor check can be performed with the check functions supplied here.

1.3 Operations on Main User Interface

1.3.1 File Selection

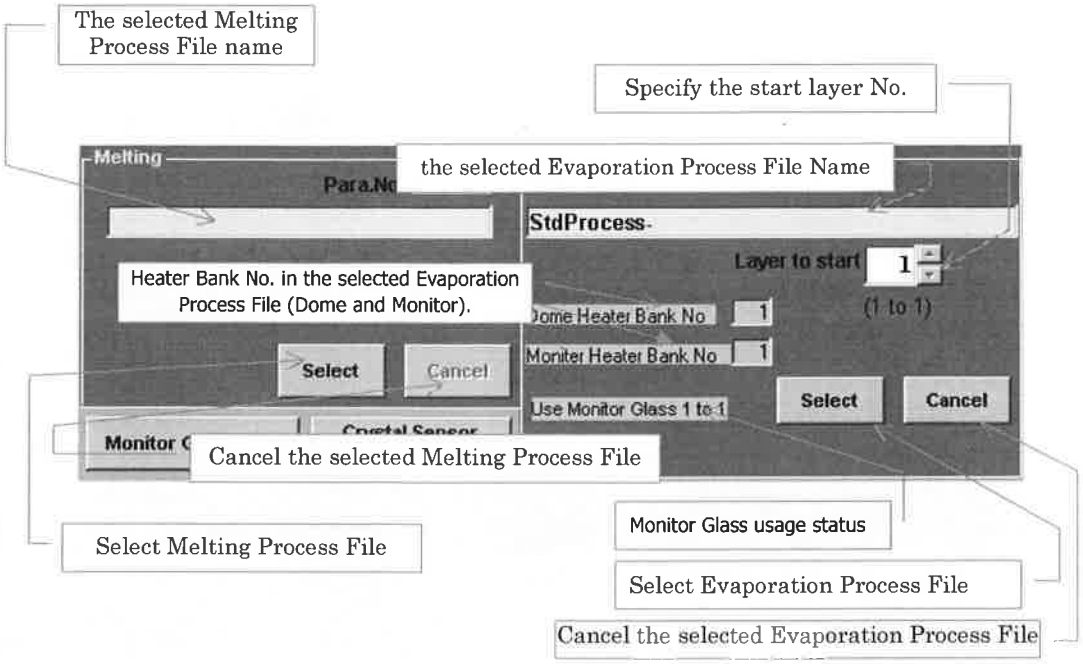


Fig. 2 File Selection Section

- Select Process File

Click the **Select** button (Melting or Evaporation Process), the following file selection user interface will be popped up:

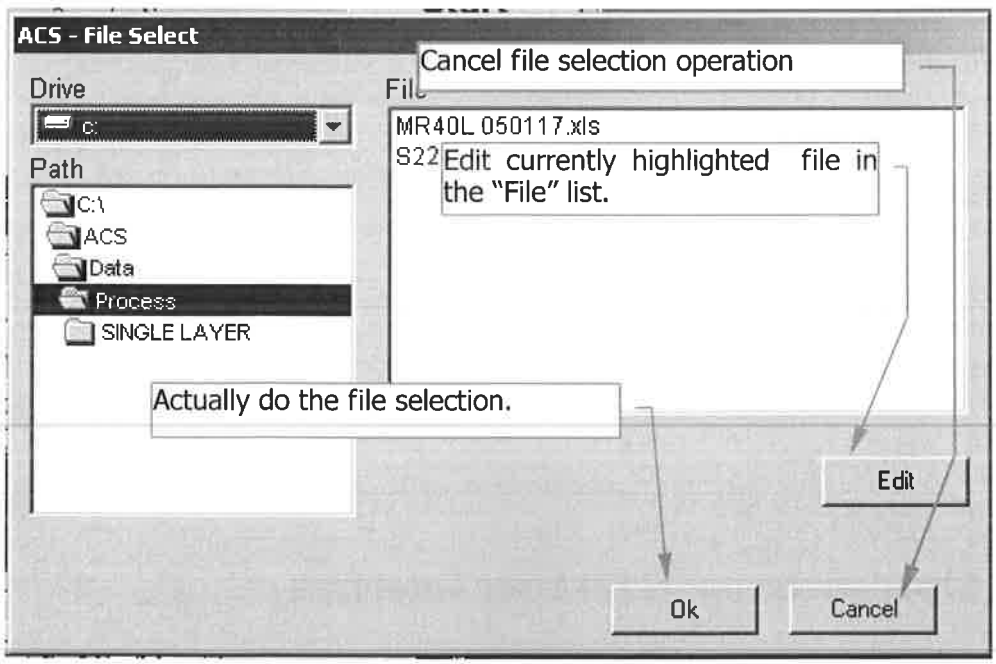


Fig. 3 File Select Operation

1.3.2 Setting Section

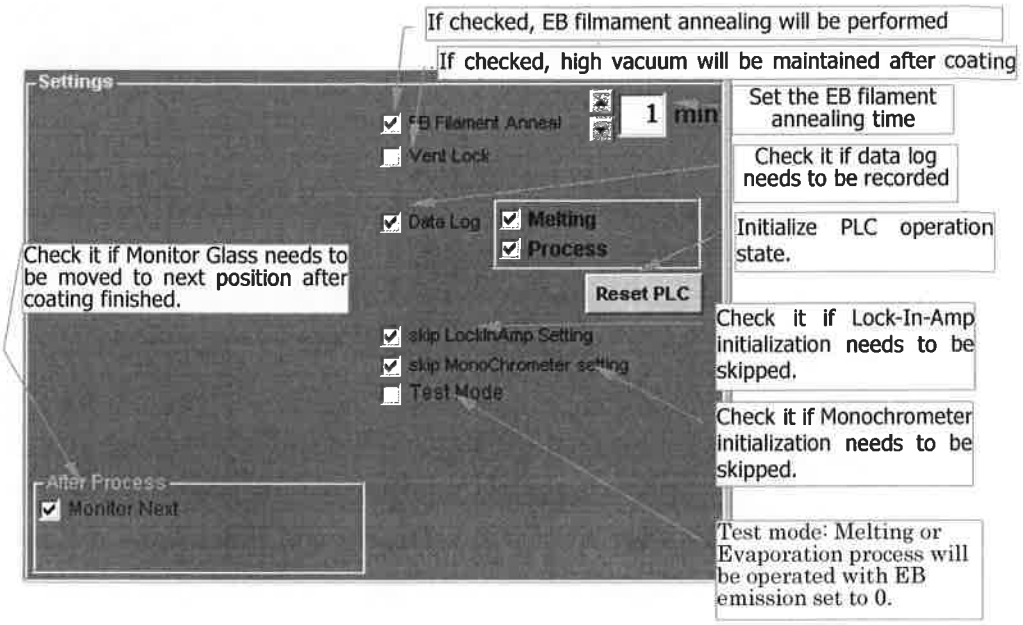


Fig. 4 Setting Section

1.3.3 Command Section

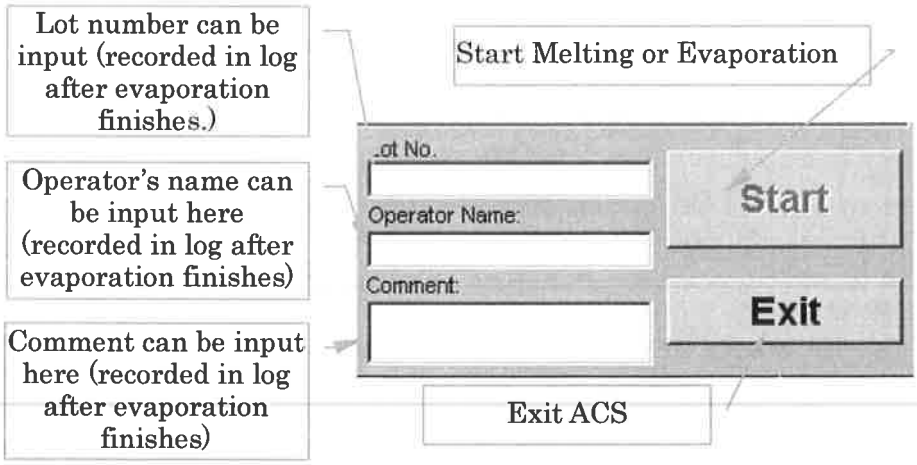


Fig. 5 Command Section

1.3.4 Evaporation Source Section

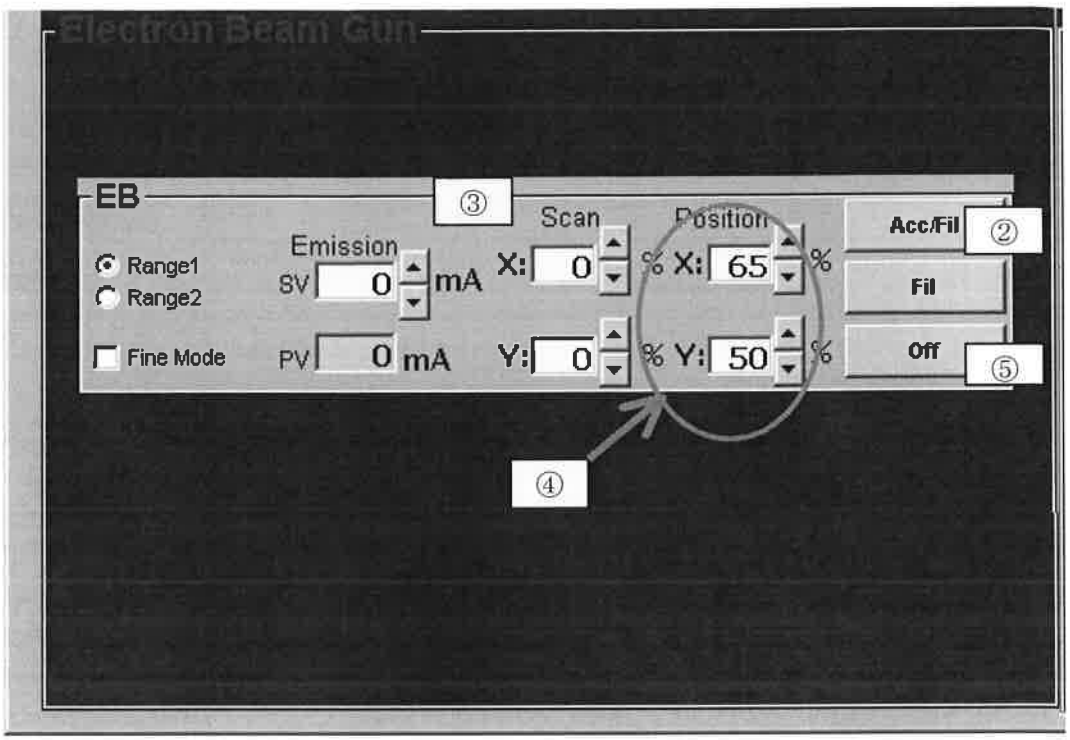


Fig. 6 EB Section – EB Tuning

EB operation can be performed through EB Section in the Main User Interface (Fig. 1). Fig. 6 is an enlarged view of Fig. 1

■ Emission:

- SV: setting value
- PV: present value, i.e. EB currently output value

■ Range:

By changing *Range* selection, setting range of EB Emission can be changed.

- Range 1: 0 ~120mA
- Range 2: 0 ~720mA

■ EB Tuning:

By changing EB Scan and position on EB section of main user interface (Fig. 1), through which EB status tuning can be realized.

1.3.4.1 EB Position Tuning

Before melting and evaporation, EB position and scan tuning are necessary. This tuning operation is to obtain appropriate position and scan parameters of EB gun for use in melting and evaporation.

■ Steps (Fig. 6)

① The "EXT-INT" switch on EB controller panel must be turned to "EXT" (which is the required normal status for automatic control with ACS system).

② Press Acc/Fil button. EB ACC and Filament will be turned on.

③ Beside *SV* and under *Emission* label, there is a Up/down button, by which EB emission's SV (setting value) can be changed.

In this way, usually a small amount of EB emission is exerted as to be able to get a good view of the exact sparkling spot (facula) created on the heated material surface by EB emission.

④ Click the X Position and Y Position button to tune the actual position status of the spot. Usually this is an alternative process between tuning and viewing (checking) the emission sparking spot.

⑤ If tuning process is over, click Off button to reset EB emission to zero.

1.3.5 Maintenance Section

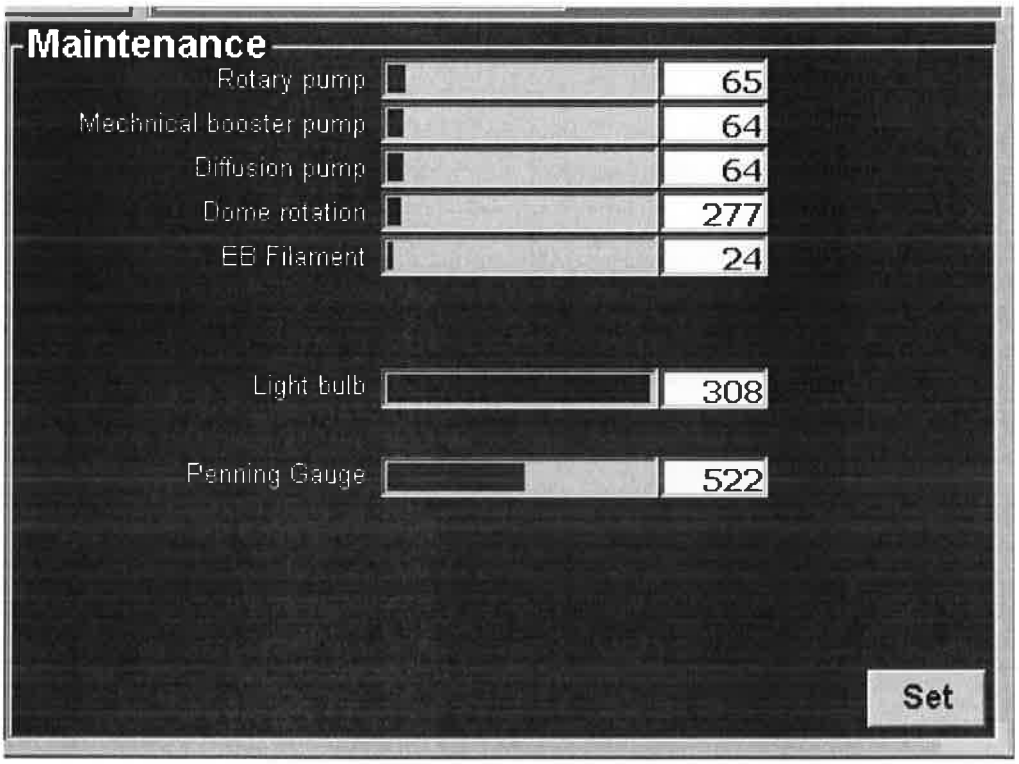


Fig. 7 Maintenance Section

In Maintenance Section, usage time of some of the coating machine's expendable parts is shown.

If usage time is shown in red digits, it means usage time has exceeded Maximum Expected Usage Time (usage life).

Click the Set button to initialize current usage time and set the Maximum Expected Usage Time. The following Fig. 8 is popped up for these operations:

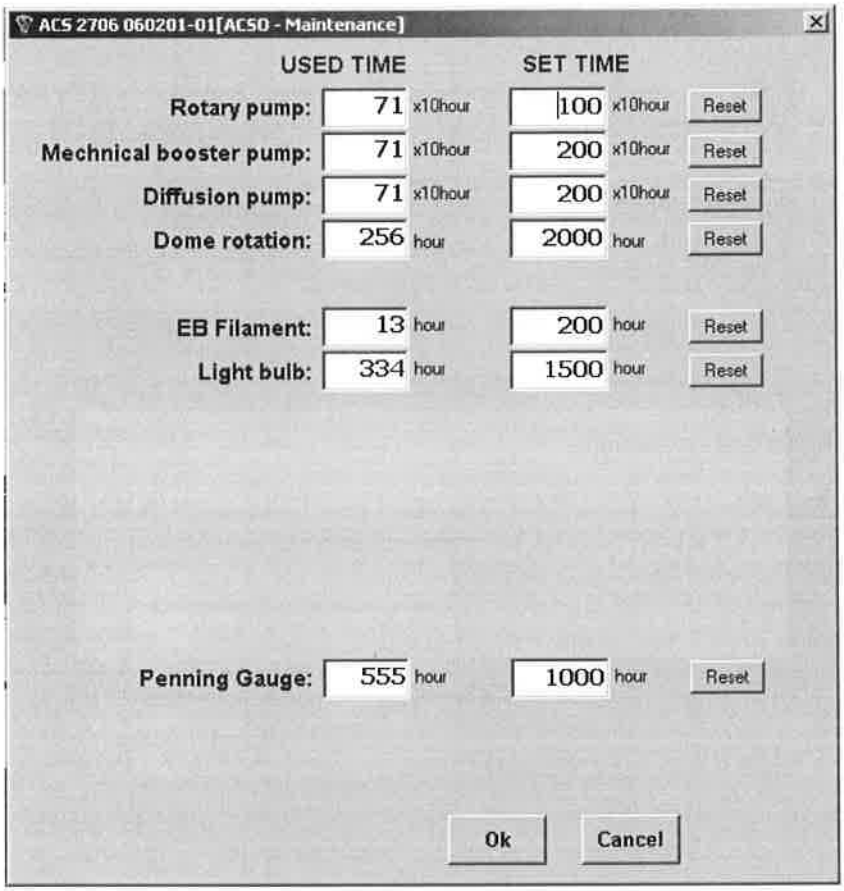


Fig. 8 Maintenance operations

1.4 Files Used by ACS

A general folder structure of ACS related files is shown in Fig. 9:

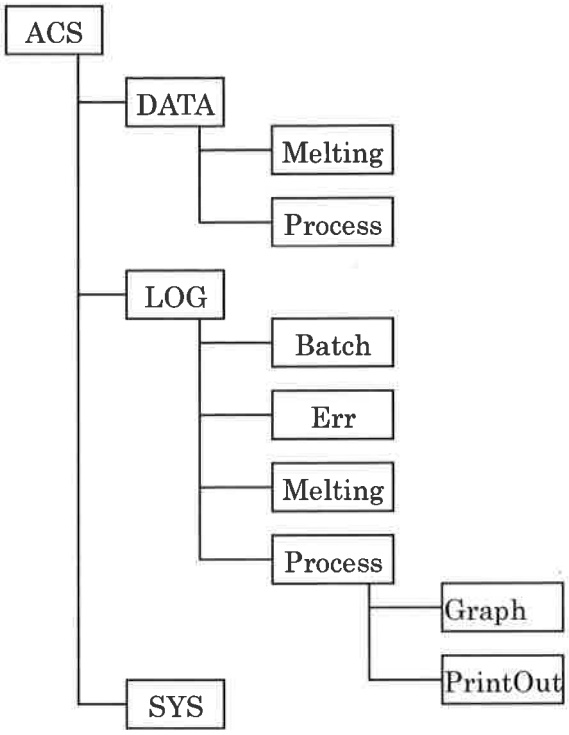


Fig. 9 ACS files

There are totally 12 folders.

- *ACS* folder

  The ACS program itself resides in this top folder of *ACS*.

- *SYS* folder

  System files are stored in *SYS* folder.

  Attention 1: Do NOT Modify SYS folder

  Access to this folder is prohibited.

- *LOG* folder

  Four subfolders follows immediately *LOG*.

  - *Batch*:

    Storing information concerning coating batches.

  - *Err*:

    Error (alarm) record and its description will be saved under this folder.

  - *Melting*:

    A general log records of melting processes.

  - *Process*:

    Storing coating evaporation log records. It further contains two sub folders: *Graph* and *PrintOut*.

    Every batch of coating will generate at least one file in each of the folders *Graph* and *PrintOut*.

    ▲ *Graph*

Storing log files with detailed records of evaporation process in interval of one second.

▲ *PrintOut*

Storing log files containing layer related records. One layer normally leaves one line of record in this log file.

■ *DATA* folder

There are two sub-folders below *DATA* folder.

- *Melting*
- *Process*

These two folder are created for storing Melting Process File and Evaporation Process File.

Note 2: Management of Process file directories

Although these two kinds of process files can be saved elsewhere, users are strongly advised to use these two folders. Users can also create and use subfolders under *Melting* and *Process* for the purpose of classification.

2. Process File

ACS uses process File for automatic coating control of Melting or Evaporation process.

Accordingly there are totally two kinds of process files:

- Melting Process File
- Evaporation Process File

(Refer to Fig. 9 for their usual storage folders in computer)

2.1 Melting Process File Editing

If a Melting Process File has been selected (as shown in Fig. 1), user can double-click the The Selected Melting Process file name part to edit it (Fig. 2 File Selection Section).

User can also open Process File for editing by double-clicking it in Windows Explorer, which is a kind of common practice in Windows system. Fundamentally Process File is of Excel format and can be operated just the way other Excel files are.

The editing user interface of a Melting Process File is shown in Fig. 10.

Note 3: Number of Hearth cup points

As an example, a 20-point type hearth configuration is presented here. The actual number of cup points varies according to each machine's specification. 30, 24, 12 and 8 points are commonly used.
Please refer to your machine's specification for actual cup point.

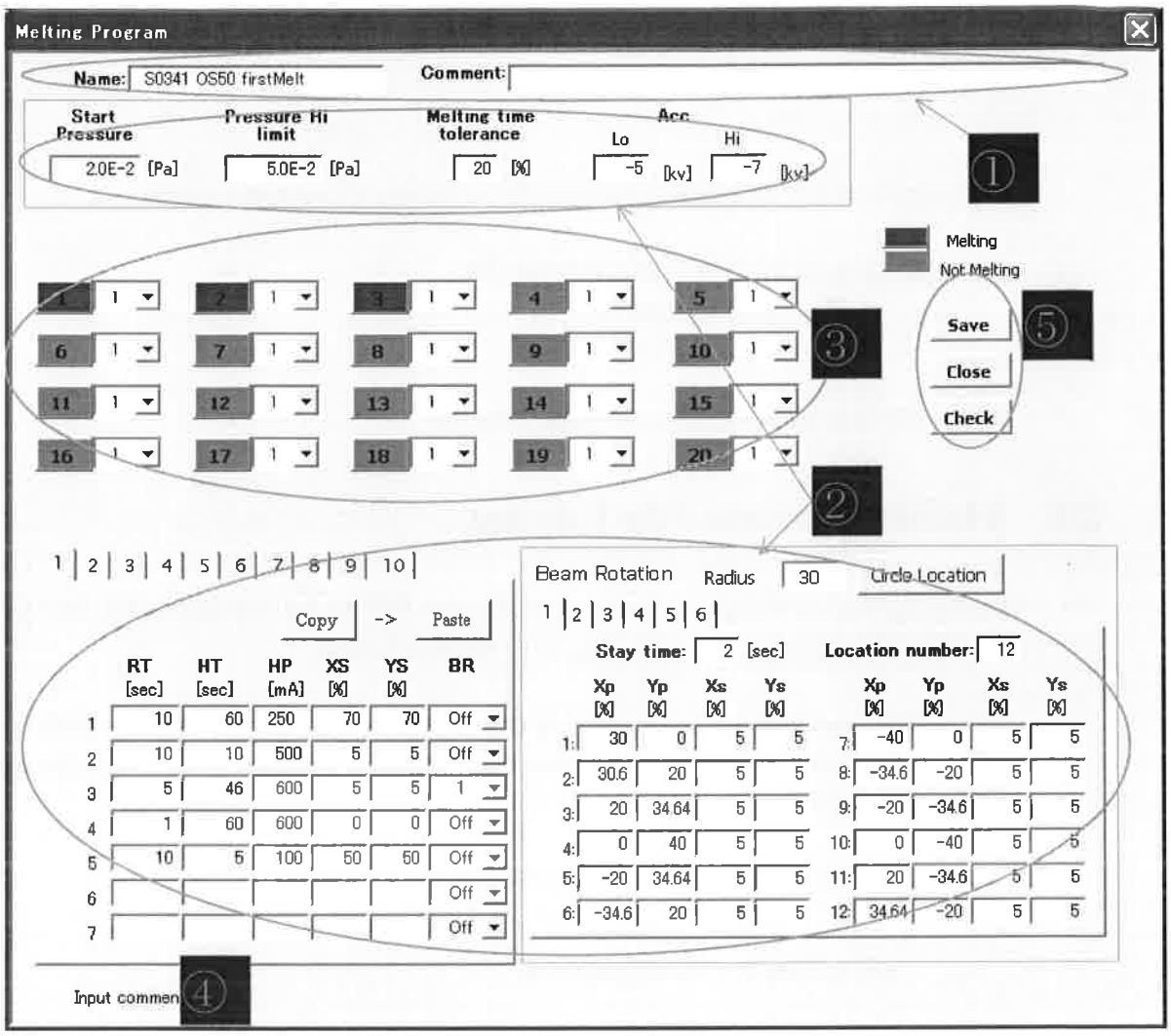


Fig. 10 Melting Process File edition

Note: the number of hearth cups might be different according to machine's specifications. Usually 12-point and 24-point types are common.

There are mainly 5 parts in Fig. 10:

① File selection

Process file name and comment information.

② Parameter settings

Parameters can be input and modified.

③ Melting options (cup specific)

These options are typical of cup-type hearth.

As shown in Fig. 10, 24 cups are available. Every cup can be individually set.

④ Hint for parameter input.

⑤ Command

Used for file save, close and error check.

2.1.1 Selected Melting file

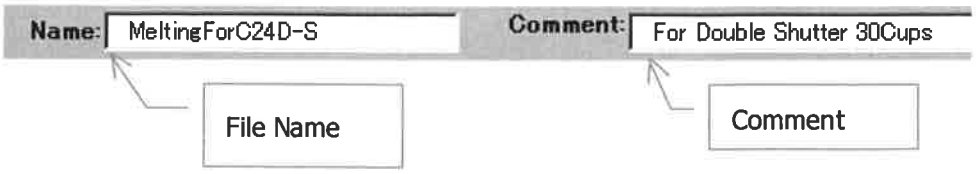


Fig. 11 Melting Process File information

2.1.2 Parameters – Batch Related

These parameters apply to the whole process of melting.

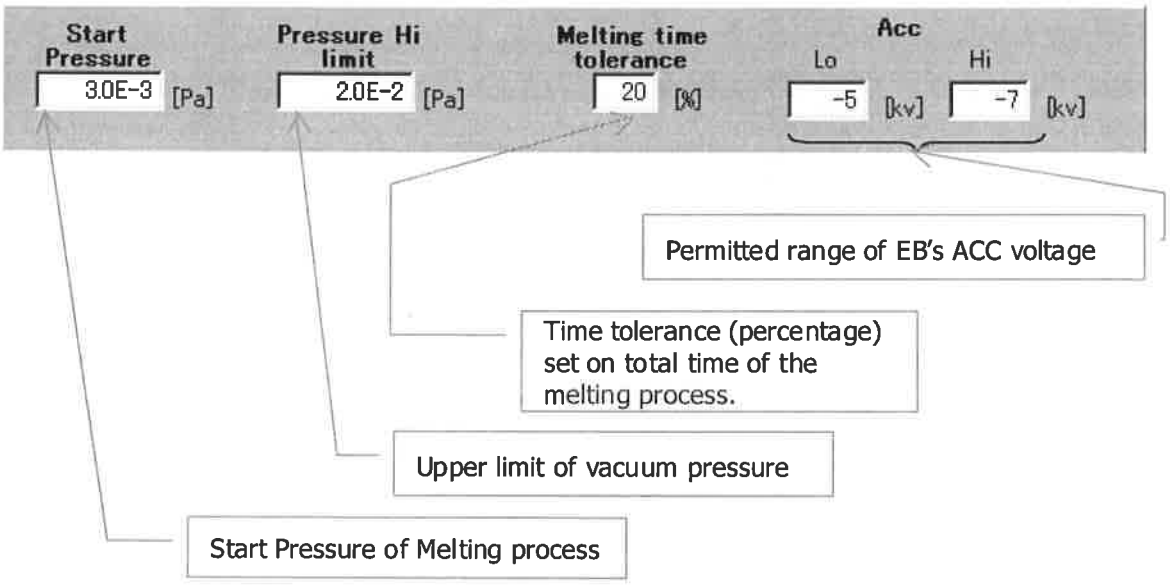


Fig. 12 Batch Related Melting Parameters

2.1.3 Parameters – Melting patterns

Melting operation usually follows such a kind of pattern:

(a) EB Emission current starts from 0 and reaches target value in linear way within a specified period of time, during which EB's scan is set according to users' settings;

(b) EB Emission current is maintained at the target value level for a specified period of time, during which user-chosen scan is used;

(a) and (b) can be repeated for a maximum of 7 times (restricted by current system).

The aforementioned (a) and (b) are combinatorially called one Melting Step.

In any Melting Step, Beam Rotation can be performed, i.e. EB position changes in rotational way.

A number of Melting Steps are formed into one Melting Pattern.

As shown in the following Fig. 13, a maximum of 10 types of Melting Patterns can be defined and used in a Melting Process File.

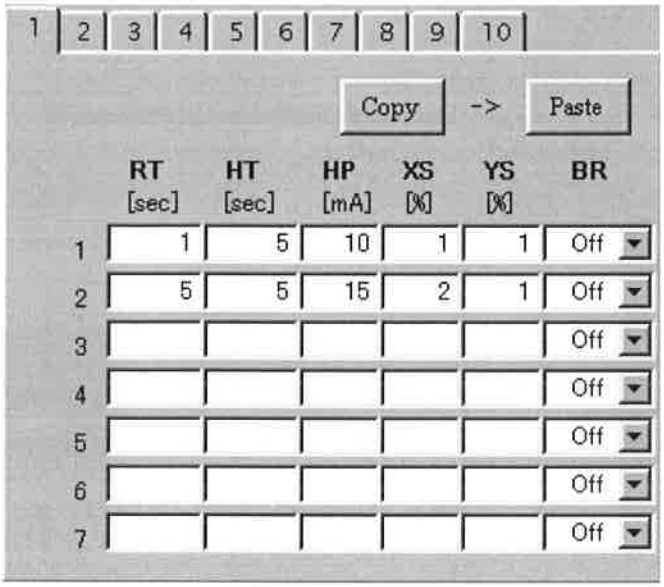


Fig. 13 Melting Patterns

Parameters for Melting Step:

- RT : The time it takes for EB emission current to reach target value(HP). Unit: second.
- HT : Holding time after target value (HP) is reached. Unit: second.
- HP : EB emission current target value. Unit: mA.
- XS : X scan value. Unit: %
- YS : Y scan value. Unit: %
- BR : Beam Rotation Pattern number. (Off: do not use Beam Rotation)

Copy button:
Clicking Copy button will copy Melting Pattern data of current pattern. Copied data can then be pasted to other patterns by clicking Paste button.

2.1.4 Parameters – Beam Rotation Patterns

Parameters related to Beam Rotation Patterns can be edited in the following user interface (Fig. 14):

At maximum 6 Beam Rotation Patterns can be defined. For each pattern, at maximum12 point of Beam Rotation Locations can be specified.

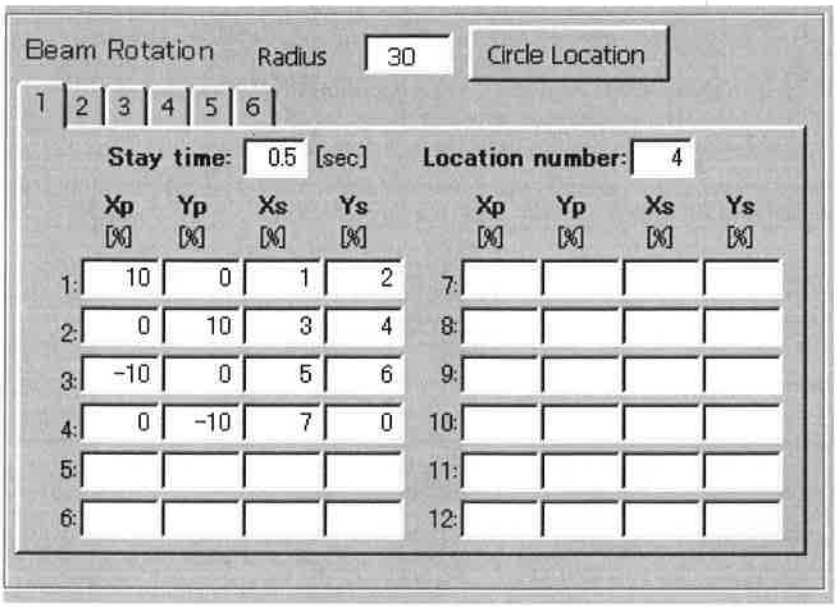


Fig. 14 Parameters - Beam Rotation Pattern

Parameters for Beam Rotation Location:

- Stay Time

  Referring to duration time for electron beam working on each of Beam Rotation Location.

- Location number

  Specifying number of locations this Beam Rotation Pattern will use (Though at maximum 12 locations are available, it is not necessary to use all of them).

- Xp

  X position setting of EB.

- Yp

  Y position setting of EB.

- Xs

  X scan setting of EB.

- Ys

  Y scan setting of EB.

Automatic calculation of locations' XP and YP parameters:

② Input *Radius*:

Radius is used for automatic calculation of Beam Rotation Locations' XP and YP parameters, in which case calculated locations will geometrically distribute around a circle of this radius.

③ Circle Location button

After pressing Circle Location button, Beam Rotation Locations can be computed for the current Beam Rotation Pattern.

Generated locations will be equal to Location number in quantity, and actual positions of these locations described by XP and YP parameters, will be evenly distributed around a circle aforementioned with its center coinciding that of hearth cup.

2.1.5 Parameters for Hearth Cups

Whether perform melting or not can be individually set for each of hearth cup.
Refer the following Fig. 15 for parameter settings for hearth cup.

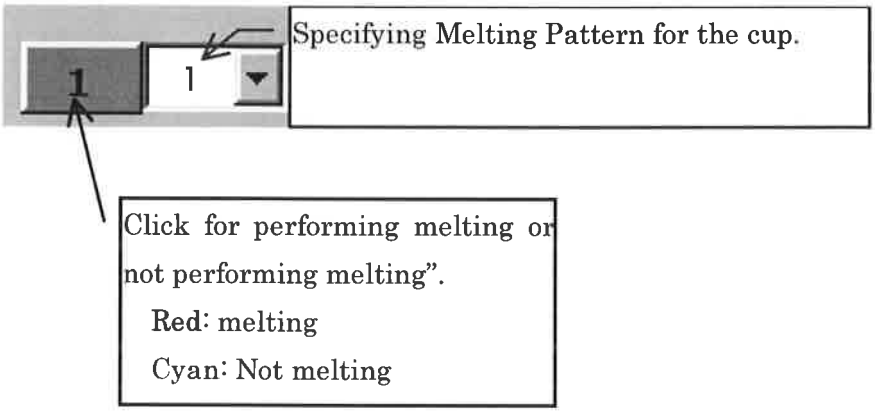


Fig. 15 Melting Parameters - Cup specific

2.1.6 Commands

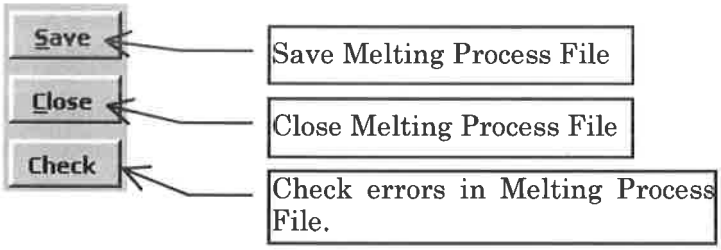


Fig. 16 Melting Process File – Commands

2.2 Evaporation Process File

If an Evaporation Process File has been selected (as shown in Fig. 1), user can double-click the "The Selected Evaporation Process File name" part to edit it (Fig. 2).

User can also open process file for editing by double-clicking it in Windows Explorer.

Edition user interface for Evaporation Process File is shown in the following Fig. 17.

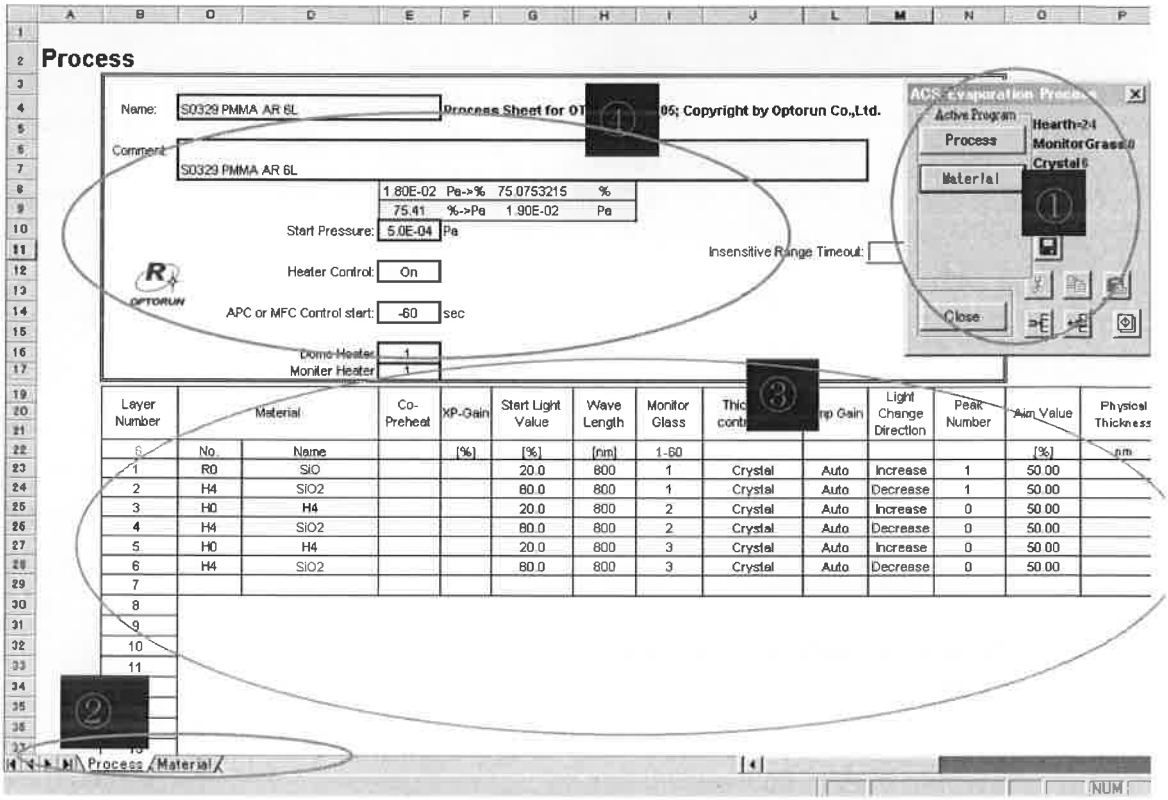


Fig. 17 Evaporation Process File Edition

Main User Interface of Evaporation Process File editor can be divided into 4 parts:

① Command Section

This part offers command operations such as file save, close, copy, paste and so on.

Attention 2 Process File *MUST* be saved using the SAVE button

Evaporation Process File must be saved using the  button shown in Fig. 17.

② Sheet Selection

Four sheets are available (② of Fig. 17): Process, Material).

③ Parameters – sheet specific

Referring to parameters corresponding to the specific sheet. In Fig. 17, this part shows process-related parameters.

④ Parameters – Batch specific

This part, residing in the top part of Process sheet, contains parameters that will be applicable to the whole coating process (batch)

2.2.1 Command Section

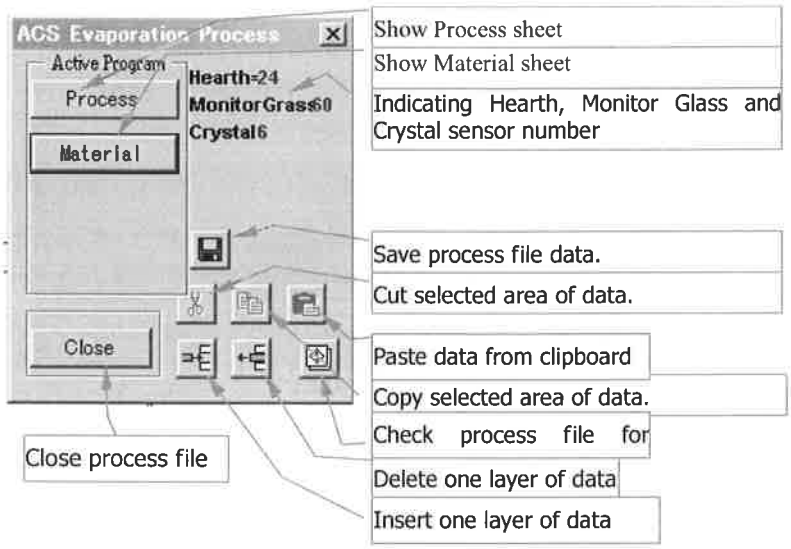


Fig. 18 Evaporation Process - Command Section

2.2.2 Evaporation Process File – Parameters for Batch

Parameters applicable to coating batch are shown in Fig. **19**:

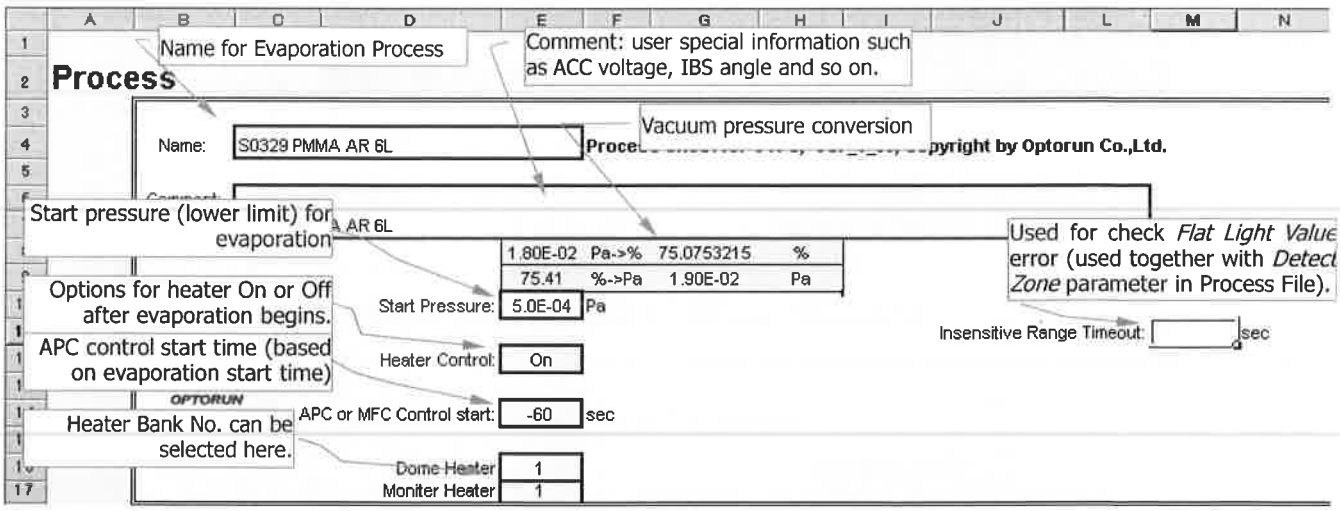


Fig. 19 Evaporation Process File - Batch-Related parameters

2.2.3 Evaporation Process File – Parameters each layers

2.2.3.1 General Parameters

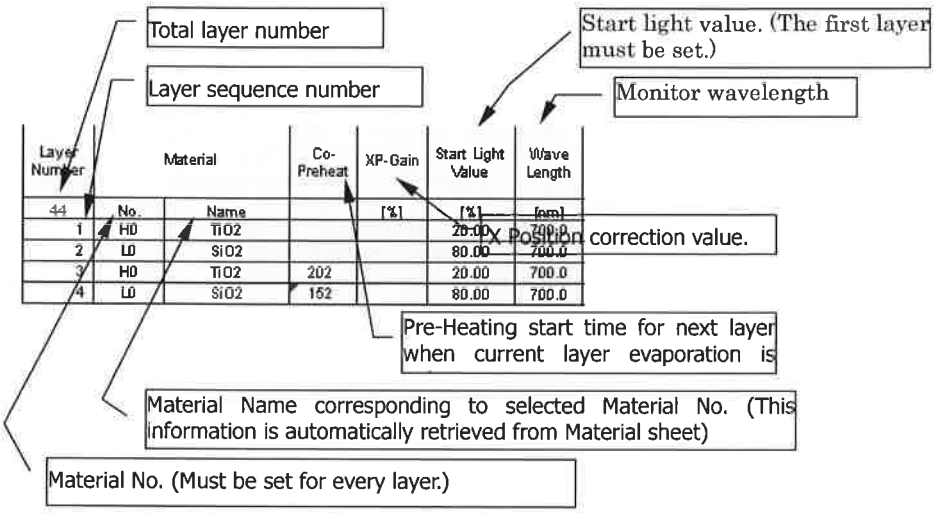


Fig. 20 Evaporation Process File – Layer Specific Prameters (Layer No, Material and Preheat)

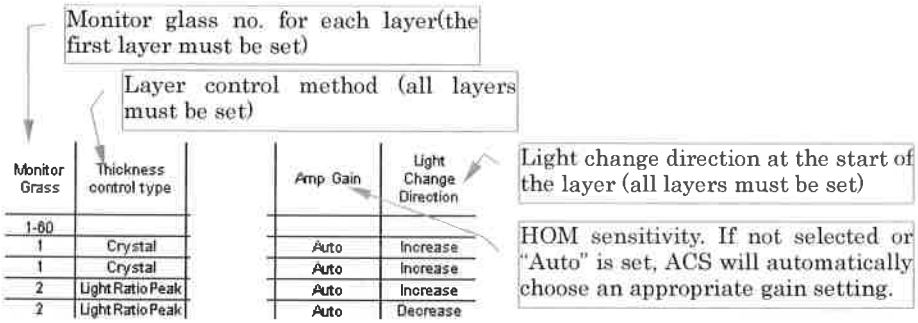


Fig. 21 Evaporation Process File – Layer-Specific Parameter (2)

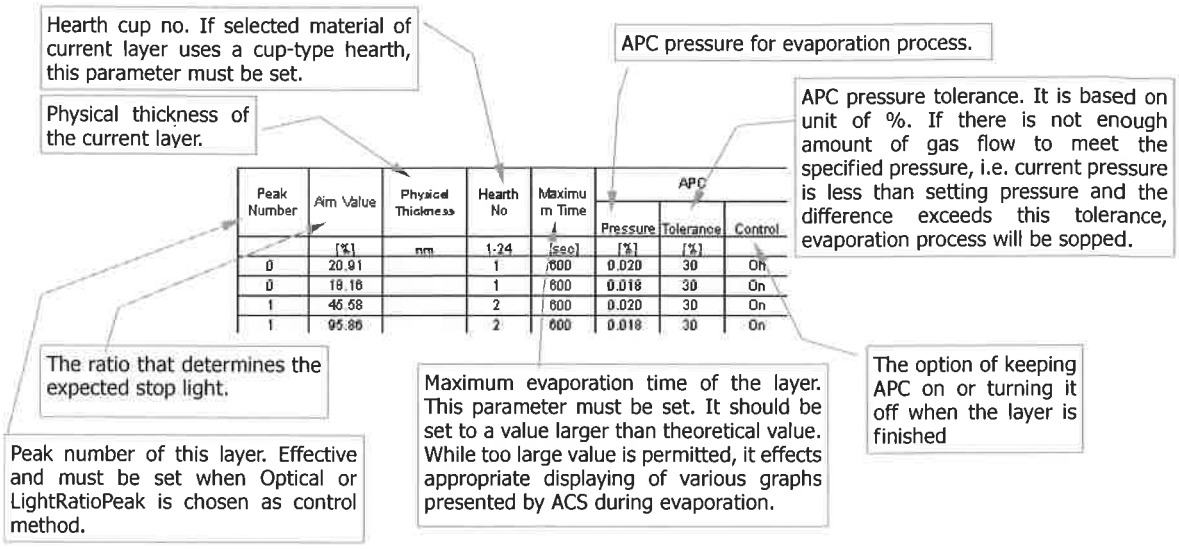


Fig. 22 Evaporation Process File – Layer-Specific Parameter (Hearth No., Max Time and APC)

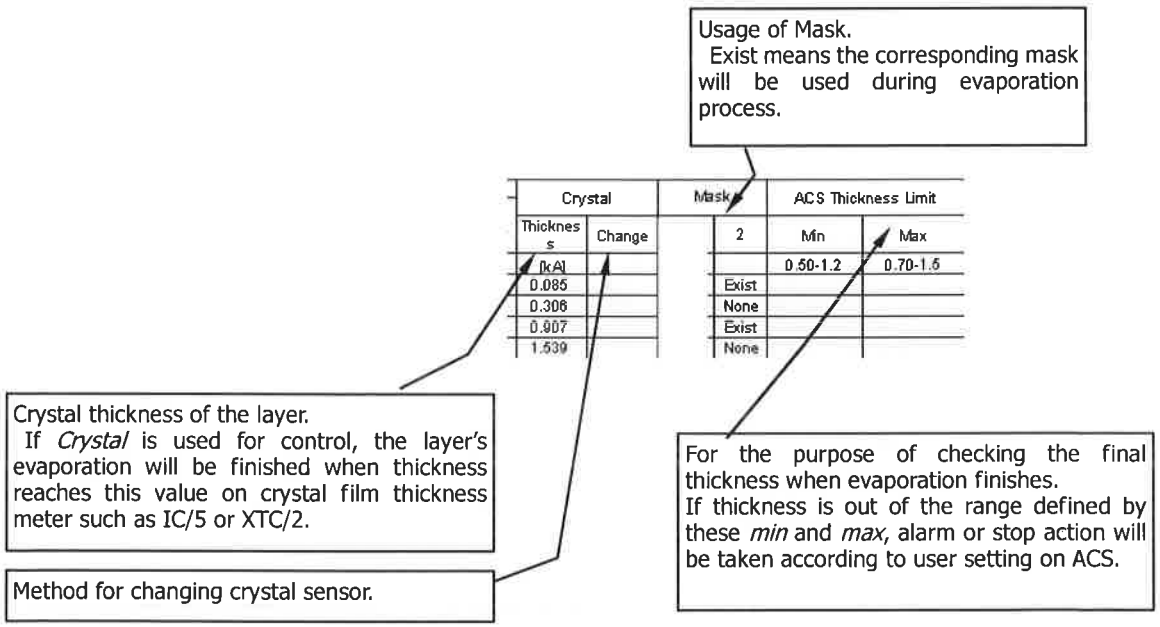


Fig. 23 Evaporation Process File – Layer Specific Parameters (Crystal, Mask and Thickness Limit)

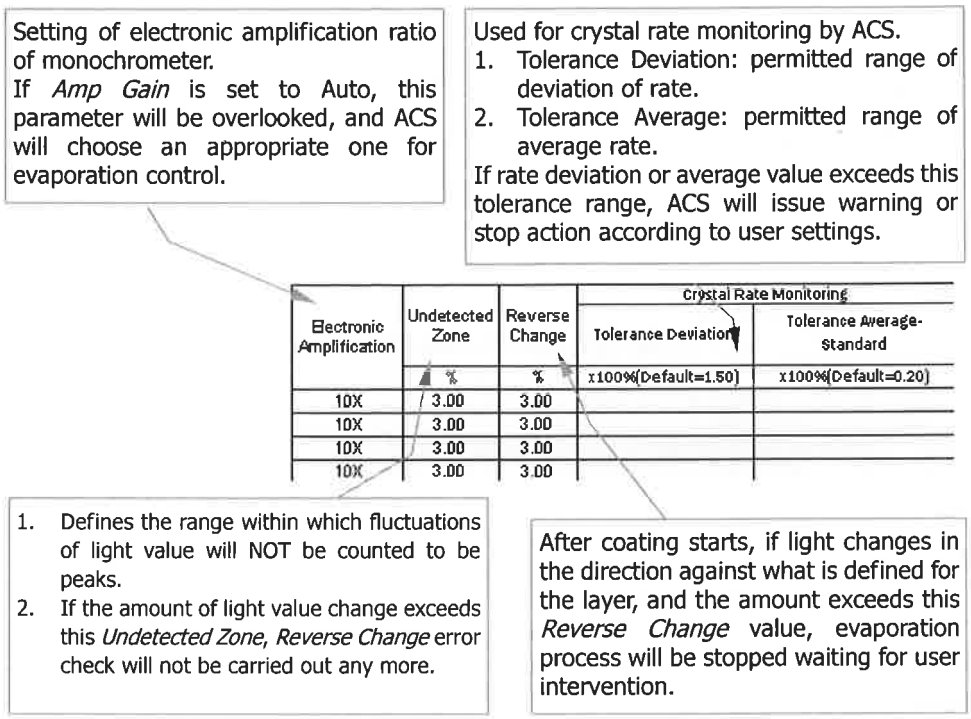


Fig. 24 Evaporation Process – Layer-Specific Parameter (Crystal Monitoring)

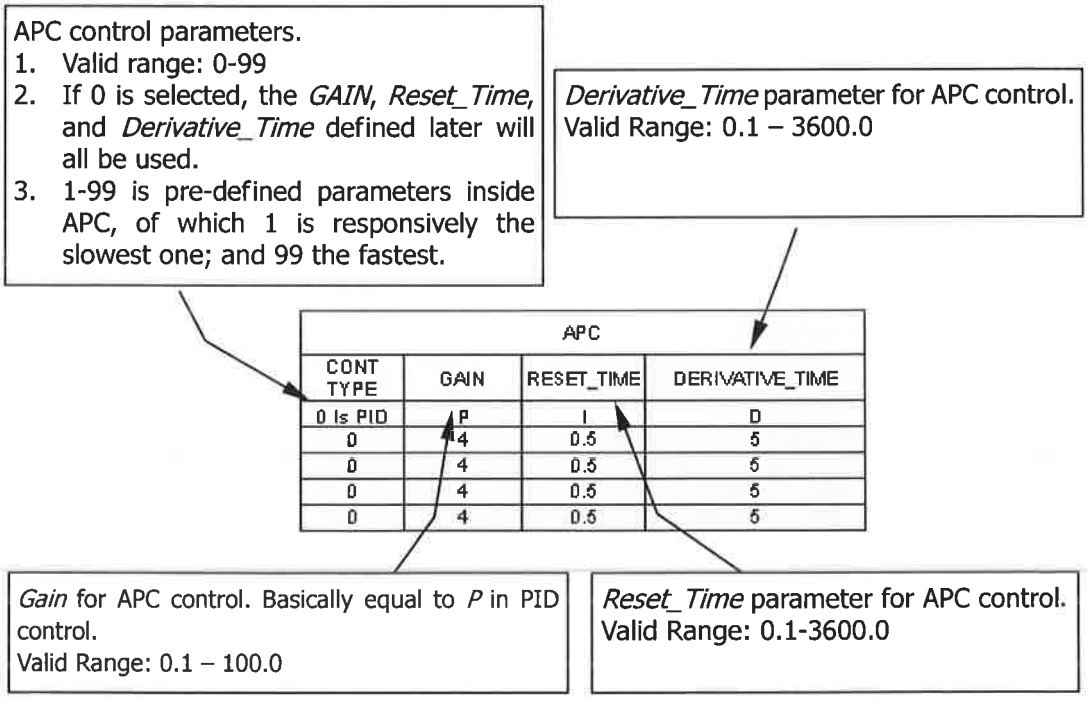


Fig. 25 Evaporation Process – Layer-Specific Parameter (APC)

2.2.3.2 TurnOver Setting

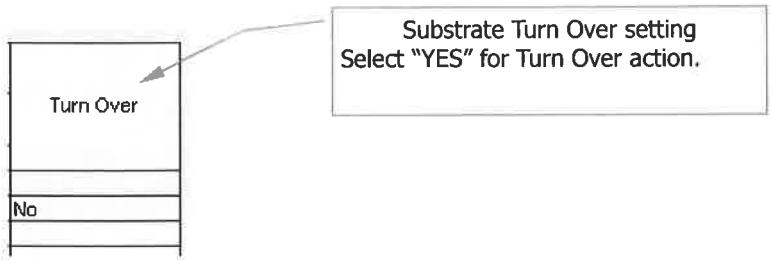


Fig. 26 Evaporation Process – Substrate Turn Over

2.2.3.3 In-Layer Temperature Setting and Waiting Parameters

Dome, Monitor and Halogen heater's temperature setting value (SV) can be modified from layer to layer. And when a new SV is applied ACS will wait for temperature's present value (PV) to get steady around the SV until the layer's coating starts.

"Steady" condition is judged by two parameters: *Temperature Steady Tolerance* and *Temperature Steady Time*.

Please refer to the following description for setting up these parameters.

(1) Temperature Settings

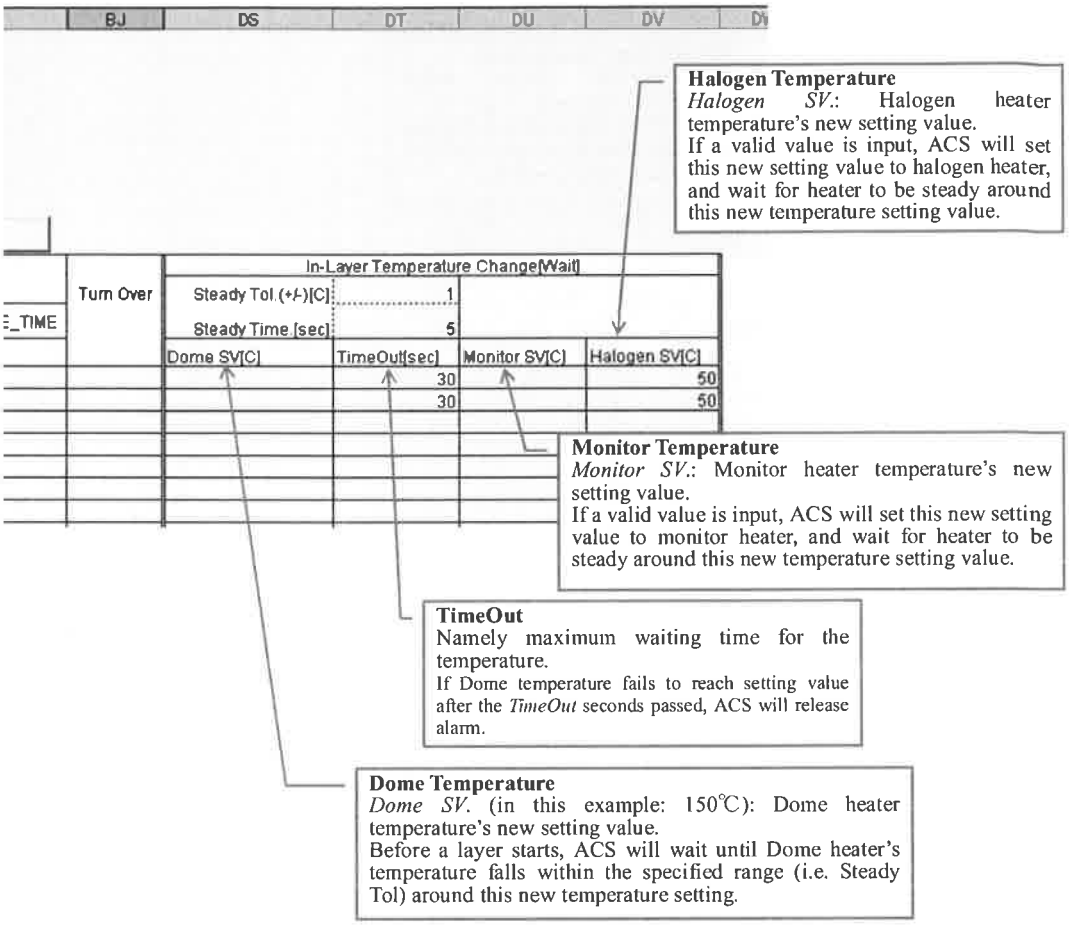


Fig. 27 In-Layer Temperature Setting – New Temperature and Time Out Parameters

(2) Temperature Steady Tolerance

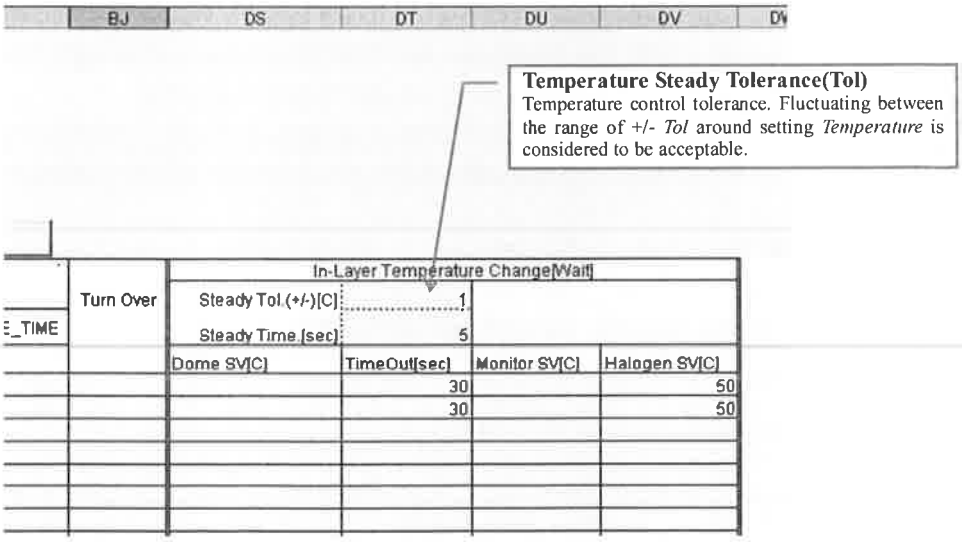
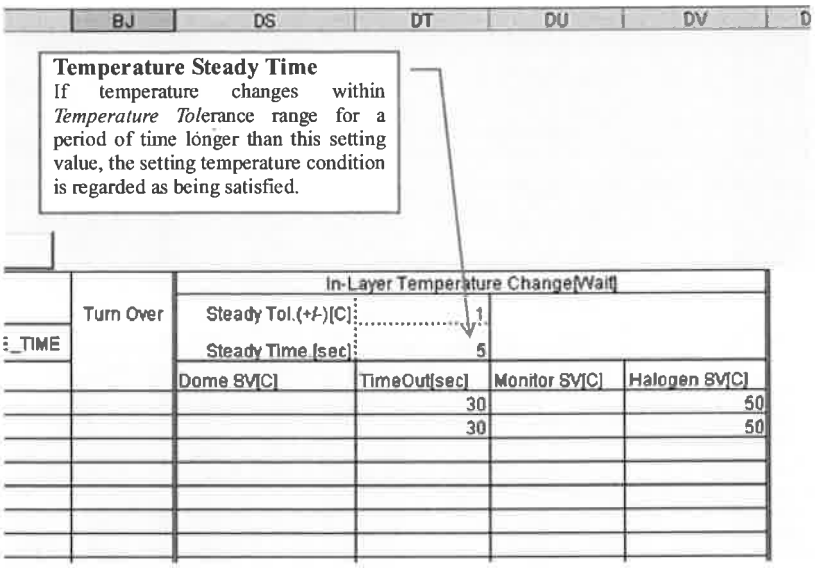


Fig. 28 In-Layer Temperature Wait – Temperature Steady Tolerance

(3) Temperature Steady Time



Temperature-wait function will take effect only when **both** *Temperature* and *TimeOut* are correctly input. For layers where this function is not used, just leave the settings blank.

Temperature Tolerance

If this parameter is not input, system default value of 20 is used, i.e. temperature fluctuation within the range of ±20 degrees is to be acceptable.

Temperature Steady Time

If this parameter is not input, system default value of 30 is used, i.e. temperature is required to be steady (within the range of *Temperature Tolerance*) for at least 30 seconds.

Attention 3: Co-PreHeat function can NOT be used if In-Layer Temperature wait function is used.

Co-PreHeat function can NOT be used if In-Layer Temperature wait function is used.
i.e. if both *Wait Temperature* and *TimeOut* parameters are correctly input, the Co-Preheat setting in "E" column (if there is any) is automatically overlooked.
Of course if the coating machine is equipped with only 1 evaporation source (e.g. one EB gun), Co-Preheat is not applicable and the aforementioned attention can be overlooked.

2.2.4 Material

In Material sheet, the following parameters are defined.

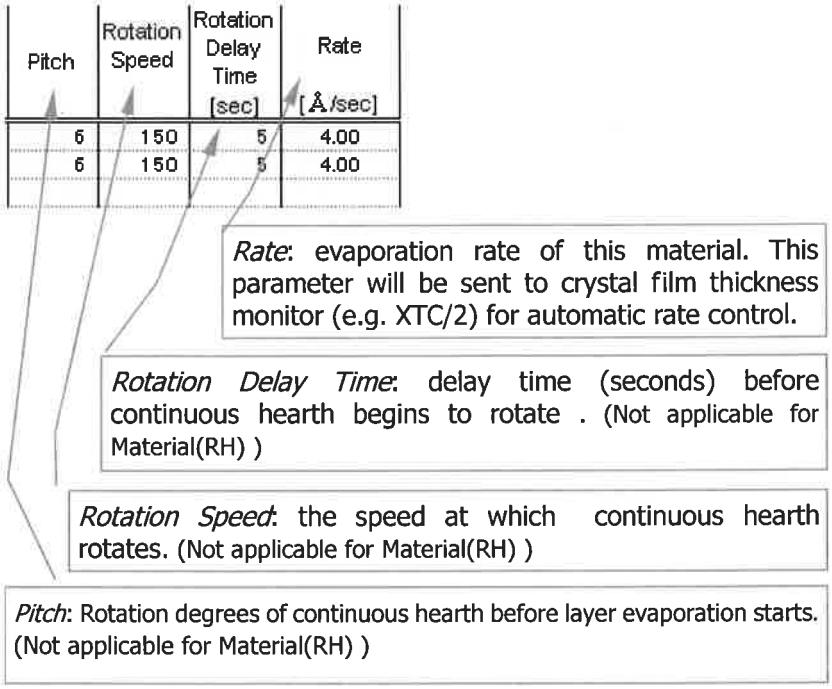


Fig. 29 Evaporation Process – Material Parameters (1)

In the following Fig. 30:

Because parameters of Step1 to Step 5 are the same, only Step 1 is explained

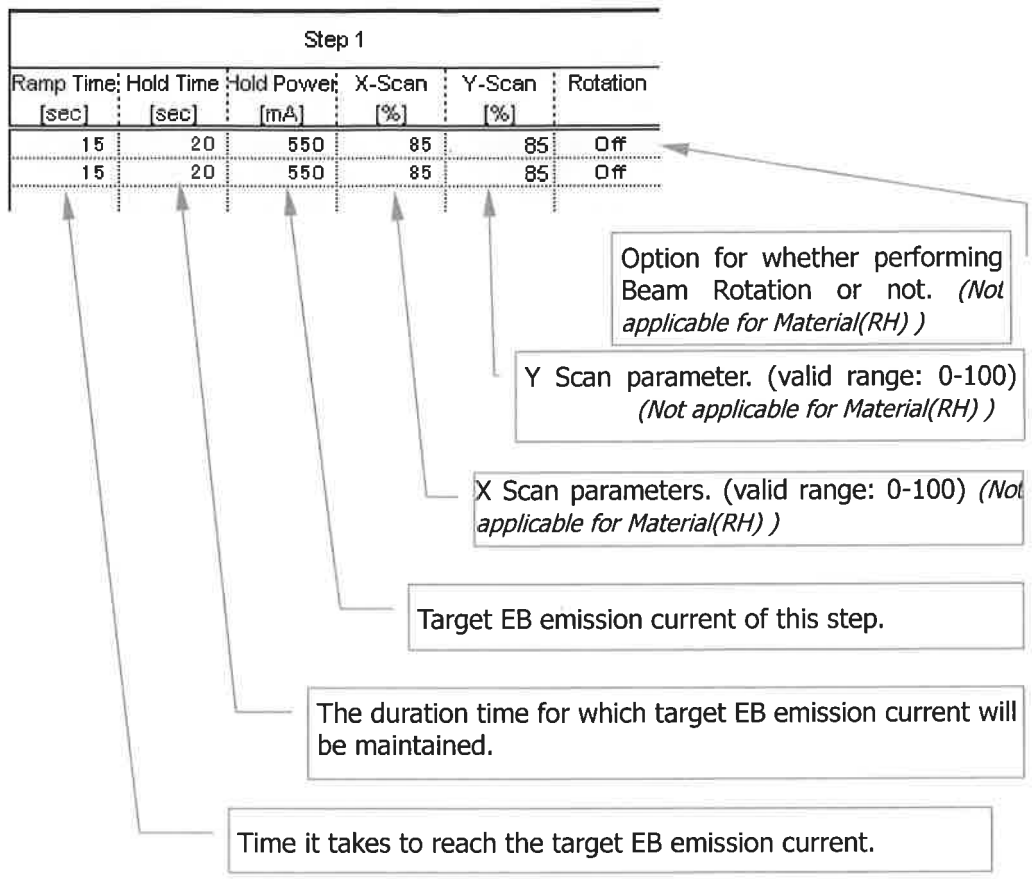


Fig. 30 Evaporation Process - Material Parameters (Steps 1-5)

In the following Fig. 31:

Because parameters of Step6 and Step 7 are the same, only Step 6 is explained.

Note 4: Pre-heating steps of material parameter.

Step 6 and Step 7 are similar to Step 1 to 5. The difference is that Step 6 and Step 7 are used immediately after a layer's evaporation finishes, i.e. after EB shutter closes, and are used for controlling EB emission to fall in a step-by-step way. This is the reason for the naming of *Fall Time* in Step 6 and 7, while in Step 1 to 5 *Rise Time* is used.

On the contrary, Step 1 through 5 is used for raising EB emission step by step before a layer's evaporation begins.

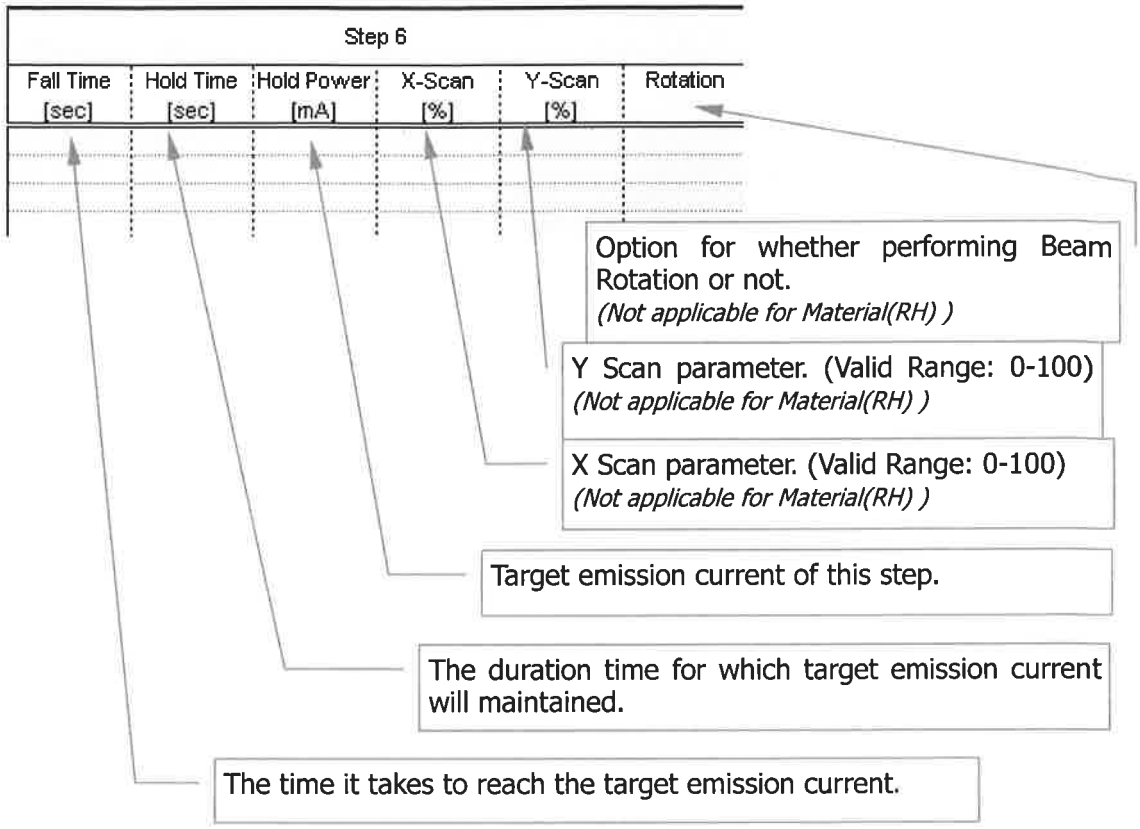


Fig. 31 Evaporation Process - Material Parameters (Steps 6 - 7)

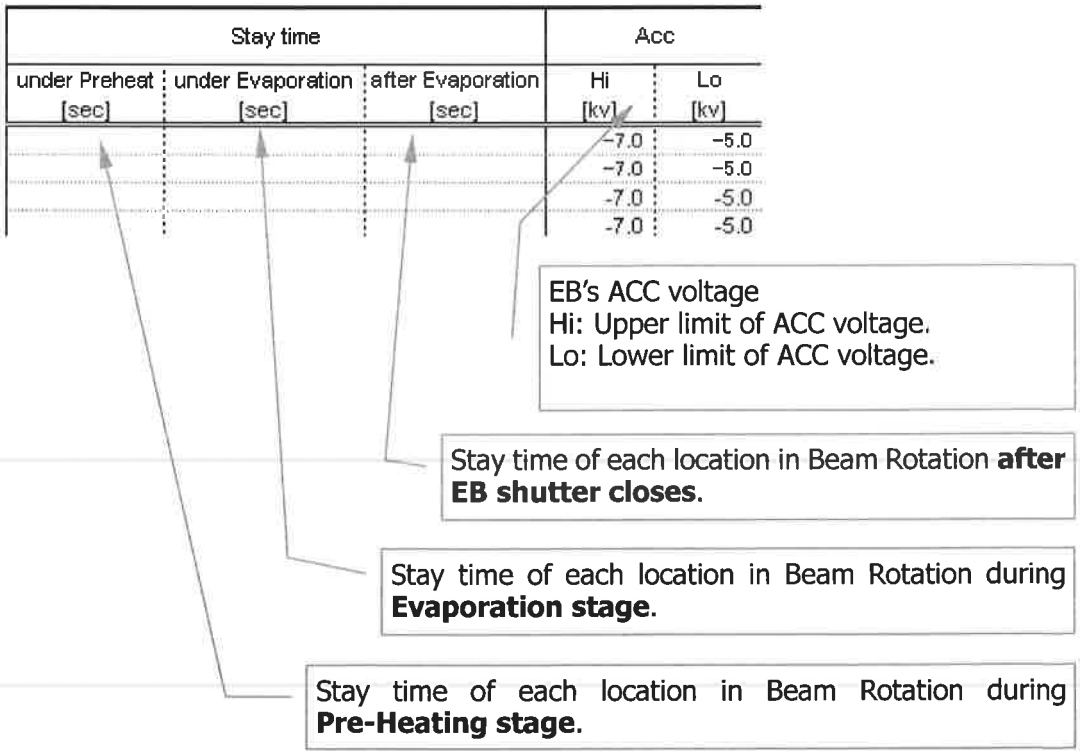


Fig. 32 Evaporation Process - Material Parameters (Stay time and ACC)

※ Because Location 1 through 8 are the same, only Location 1 is explained in the following Fig. 33

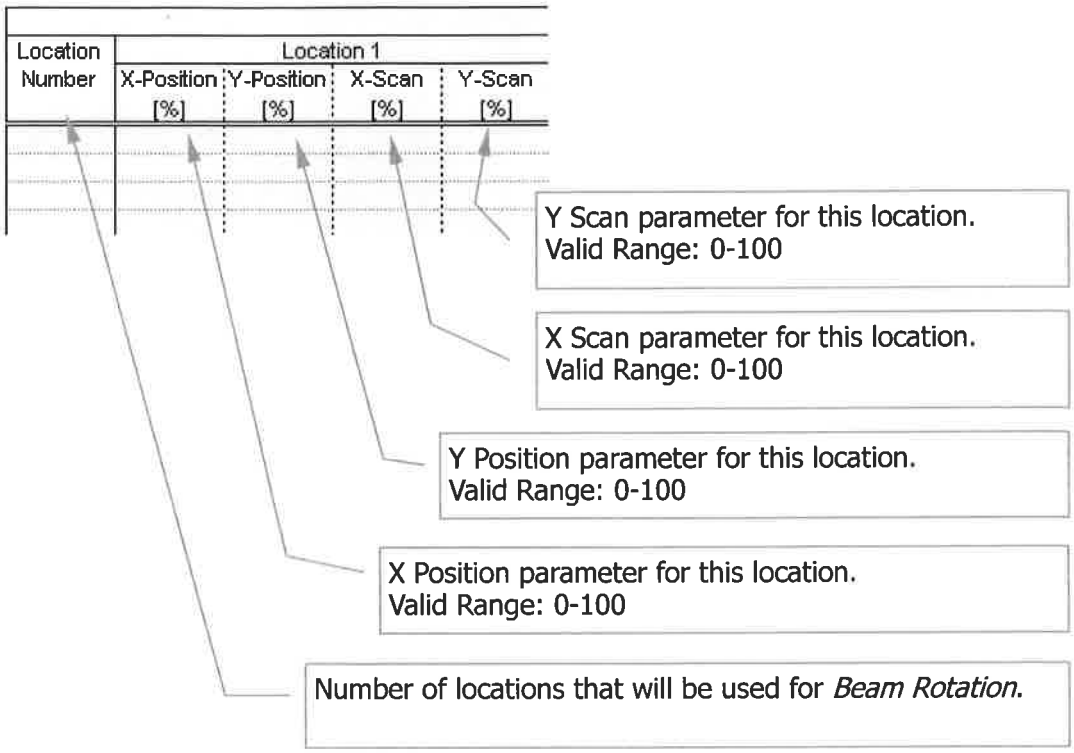


Fig. 33 Evaporation Process - Material Parameters (Location Number and Location)

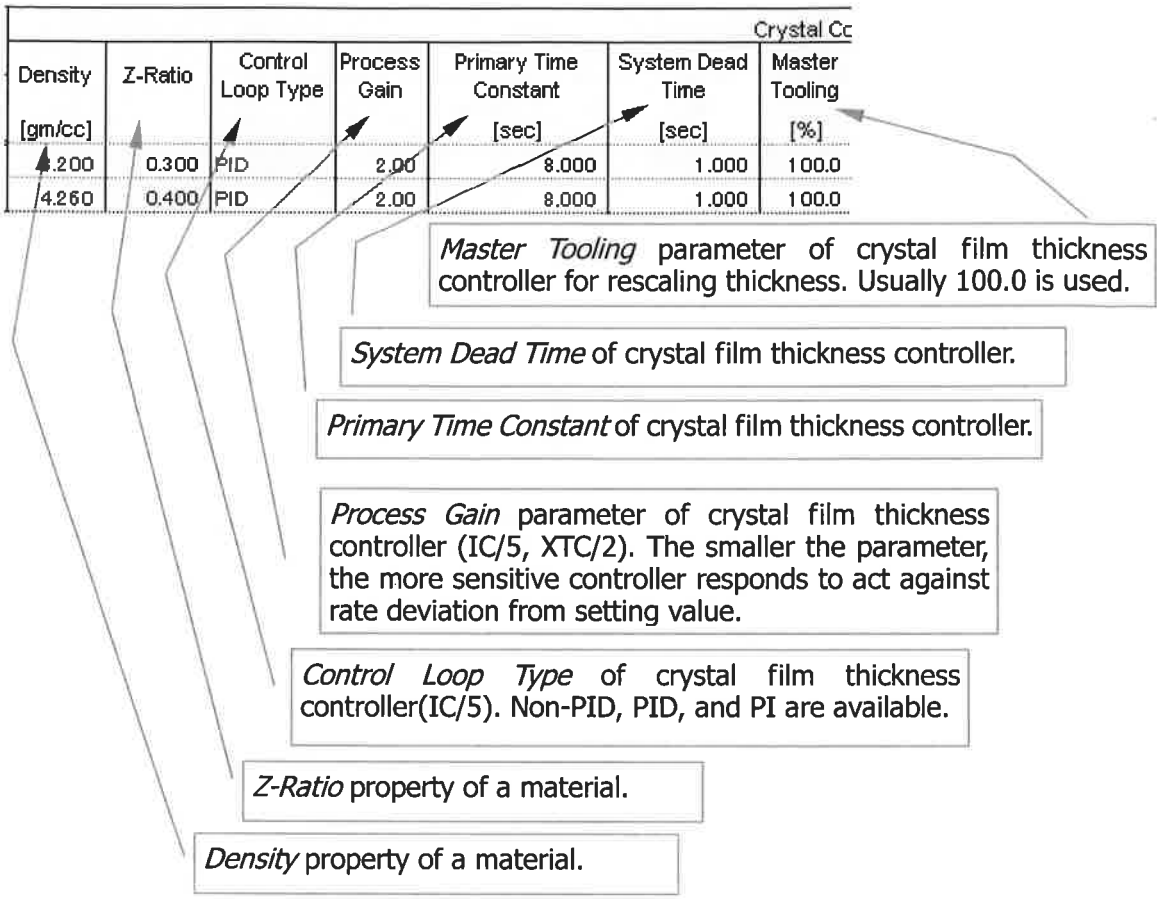


Fig. 34 Evaporation Process – Crystal Control (1)

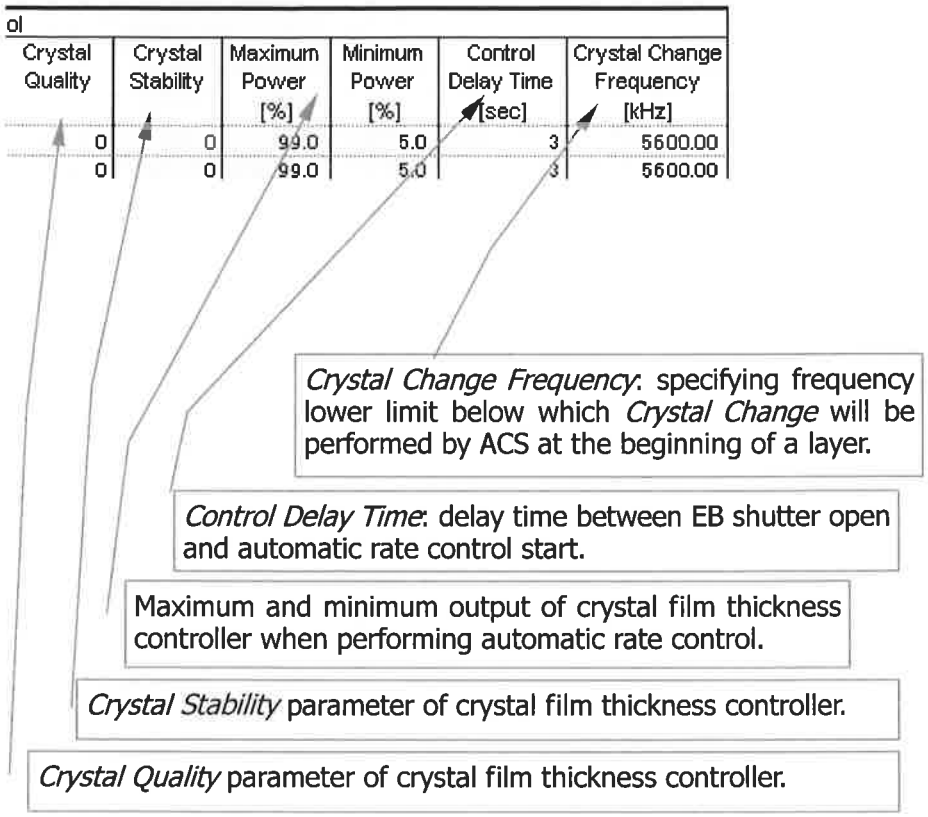


Fig. 35 Evaporation Process – Crystal Control (2)

3. Melting

3.1 Start

To start *Melting Process*, please follow the next steps:

2. Select Melting Process File. (① of Fig. 36)
3. Press Start button(② of Fig. 36).

Name of the selected Melting Process File is displayed at ② in Fig. 36.
Press Cancel button (③) to cancel a selected Melting Process File.

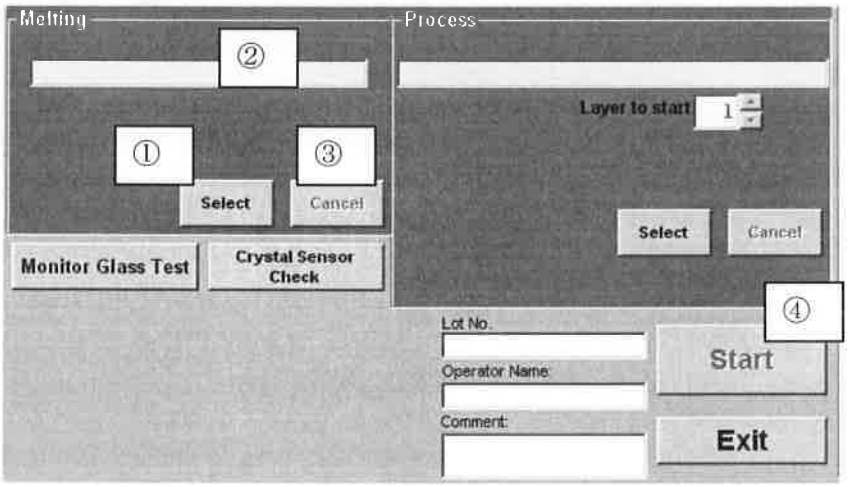


Fig. 36 Start Melting Process

3.2 Melting Process

The following Fig. 37 represents a typical user interface of Melting Process.
(Please refer to Note 3: as for hearth's cup number)

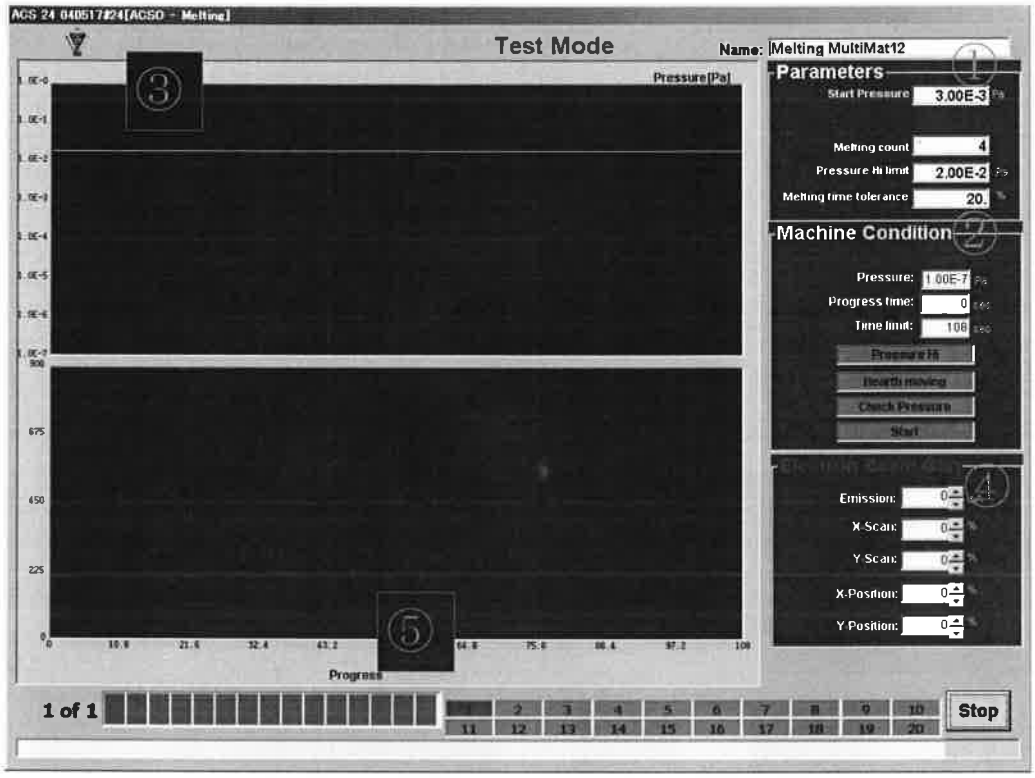


Fig. 37 Melting Process – User Interface

Fig. 37 can mainly be divided into 5 parts:

① Parameter name

Equal to the Name field in Melting Process File.

② Status

Displaying status of Melting Process: vacuum pressure, processing time, hearth rotation state, vacuum check indicator, and melting start (ongoing) indicator.

③ Pressure and EB emission graph

Pressure and EB emission current data are represented in these graphs.

④ EB tuning

EB can by tuned in terms of emission current, X Scan, Y Scan, X Position, and Y Position.

⑤ Cup status

Displaying melting status of all Cups on the hearth.

3.2.1 Parameter

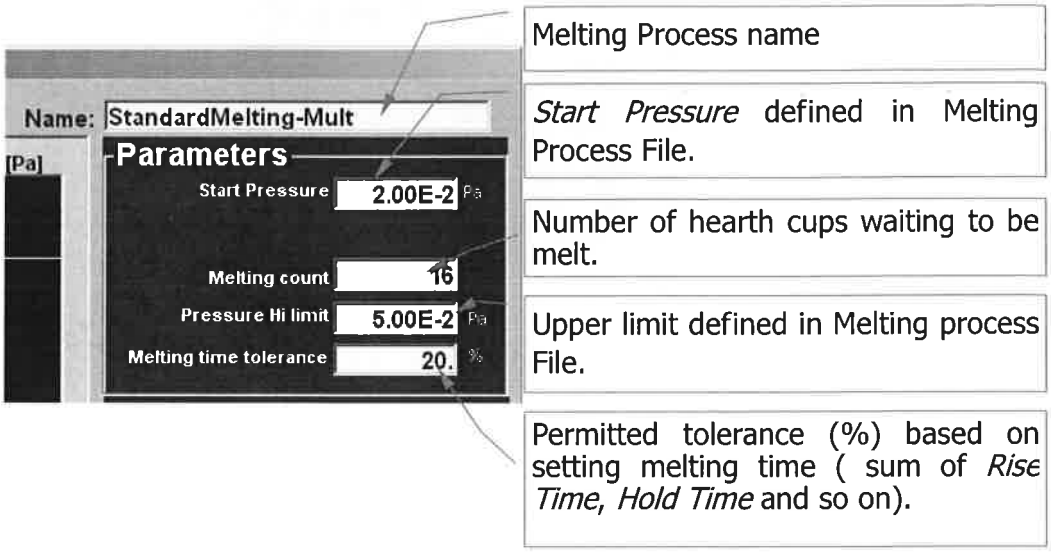


Fig. 38 Melting Process – Parameter section

3.2.2 Melting Status

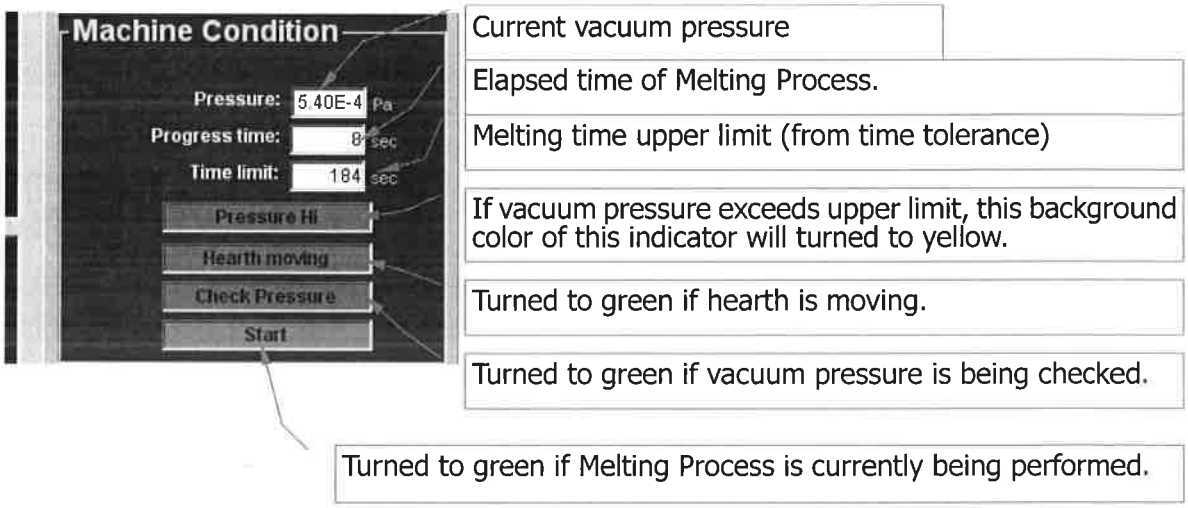


Fig. 39 Melting Process – Melting Status section

3.2.3 EB Tuning

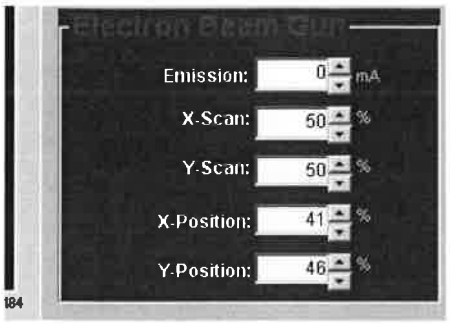


Fig. 40 Melting Process – EB Tuning

Current EB parameters values are displayed.

For adjustment of EB parameters (Emission, X Scan, Y Scan, X Position, and Y Position),  can be used.

Note 5: Parameter changes effective only to current processing

Parameter changes (Emission Current, X Scan, Y Scan, X Position, and Y Position) made here are only effective temporarily for ongoing Melting Process of the current Hearth Cup. When next Cup melting begins, parameters defined in Melting Process File will be resumed.

After Melting Process finishes, X Position and Y Position are always restored to original values before Melting Process starts (that is shown in Fig. 1 before Melting started).

3.2.4 Cup Status

(Please refer to Note 3: as for hearth's cup number)

Fig. 41 Melting Process – Cup status

In Fig. 41, a map of total Hearth Cups' status is displayed.

Cups are marked with these colors:

- Red:
  The Cup is specified in Melting Process File to perform melting in this Melting Process.
- Orange
  The Cup's melting processing has finished.
- Cyan
  The Cup is not included for melting operation in this process.

4. Evaporation

4.1 Start

To start *Evaporation Process*, please follow the next steps:

1. Select Evaporation Process File. (① of Fig. 42)
2. Press Start button(④ of Fig. 42).

Name of the selected Evaporation Process File is displayed at ② of Fig. 42. Double-click part ② will lead to edition of Evaporation Process File.

Press Cancel button (③) to cancel a selected Evaporation Process File.

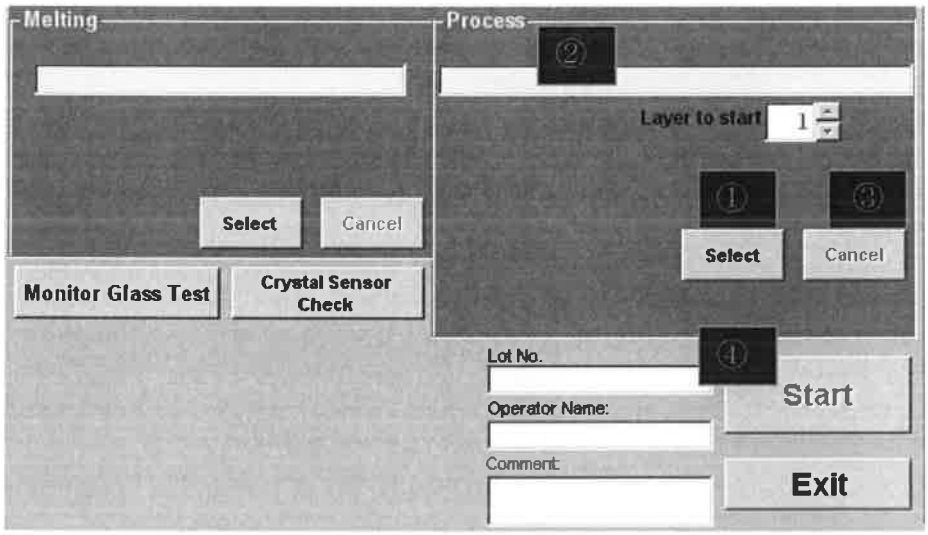


Fig. 42 Evaporation Process - Start

Note 6: Melting and Evaporation

In the case Melting Process File and Evaporation File are both selected, Melting Process will be first executed after Start button is pressed.

Attention 4: Heater Bank applied once Process is selected

Once Evaporation Process File is selected, its Heater Bank No parameters will be sent to PLC directly and take effect immediately.

4.2 Evaporation Flow

Evaporation Process is executed in the following sequence:

① GP-IB communication test
② Recovery options
③ Monitor Glass Confirm
④ Toggle switch mode check
⑤ EB Filament annealing (Can be skipped)
⑥ Evaporation start condition check
⑦ Monochrometer and Lock-In-Amp initialization (can be skipped)
⑧ APC check
⑨ Layer evaporation

4.2.1 GP-IB communication test

The following parts of Optorun's coating machines use GP-IB communication protocol:

1. HOM2-N (monochrometer)
2. HOM2-D (Lock-In Amp)

GP-IB test user interface is show as Fig. 43. If no error is found evaporation process will proceed to next step.

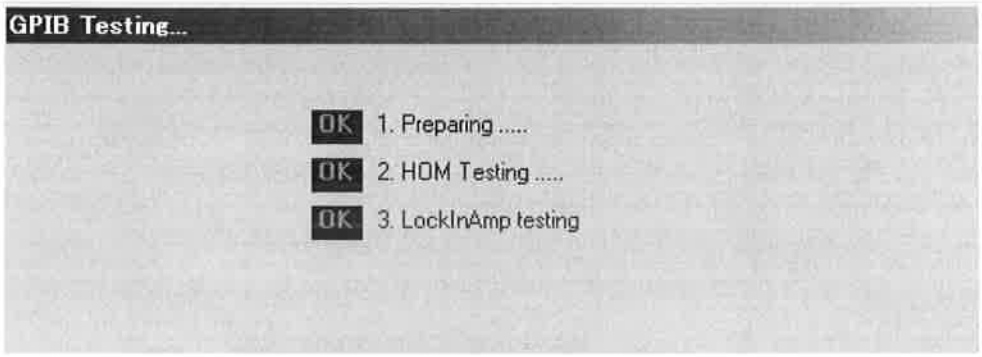


Fig. 43 Evaporation Process – GPIB test

4.2.2 Recovery Option

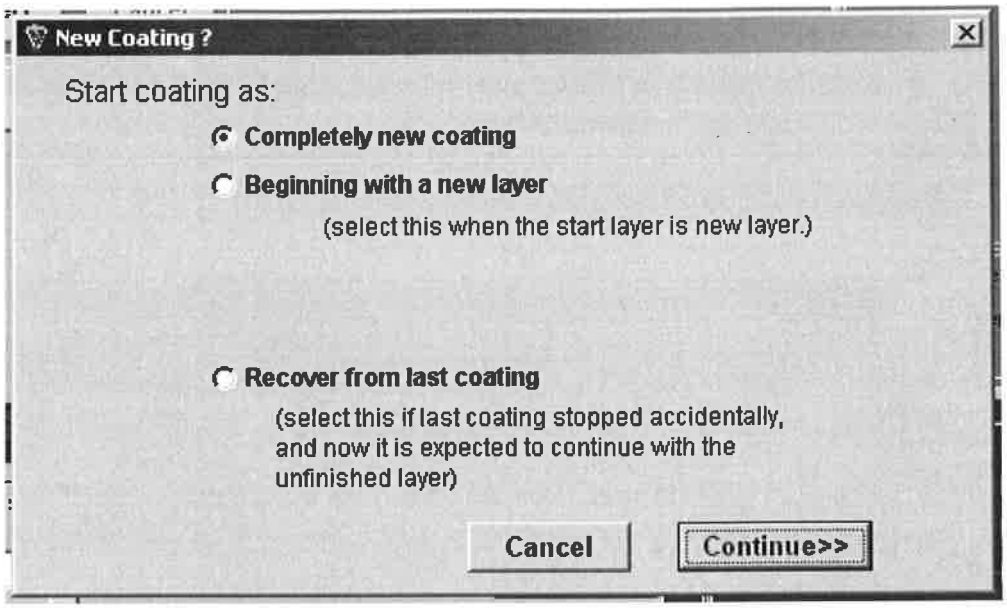


Fig. 44 Evaporation Process – Recovery option

One of the following 3 options must be made:

1. Complete New Coating
   Choose this if this is a completely new batch of evaporation process.
2. Start from New Layer
   This is not a complete new coating, but the start layer is new and not tried before.
3. Continue from Last Coating
   This batch continues from an unfinished layer of last batch. This is called *Recovery* action.
   This is usually such a case:
   - ACS stopped due to error in the middle of a layer's evaporation (Fig. 72 Alarm User Interface);
   - ACS was returned to the Main User Interface (Fig. 1).

Attention 5 Limitations of Recovery Function

If *Recovery* has been performed on a layer for several times, it is probable that successful automatic control of the layer can NOT be realized. In this case, user monitoring and/or intervention of the layer's evaporation process is necessary.

4.2.3 Monitor Glass Position confirm

Primary purpose of Monitor Glass Position Confirm step is to give user a chance to reassure that monitor glass usage starts from the correct position.

This serves to avoid such troublesome situations in Evaporation:

- Monitor Glass positions are not fit for evaporation (e.g. already used)
- There are not enough positions left to fulfill the complete Evaporation Process.

Attention 6 Monitor Glass

Incorrect use of monitor glass will result in production failure if optical control (*Optical*, *LightRatioPeak*) method is used.

User interface of Monitor Glass position confirm is shown in Fig. 45:

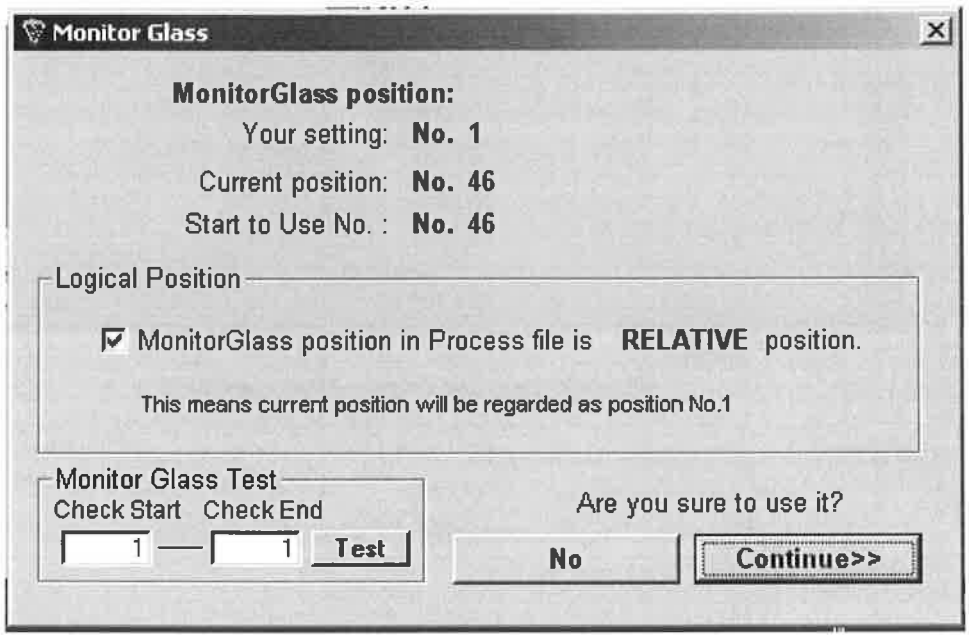


Fig. 45 Evaporation Process – Monitor confirm

If monitor glass needs to be checked, input Check Start and Check End textbox, and then press Test button.

The checkbox of Use Relative position means that :

- Current monitor glass position will be the first one to be used in this evaporation process;
- Settings of monitor glass positions in Evaporation Process File will treated as relative positions by ACS.

4.2.4 Toggle switch mode check

In this step, ACS perform a check of operation mode of these switches:

- Dome rotation
- EB controller internal / external

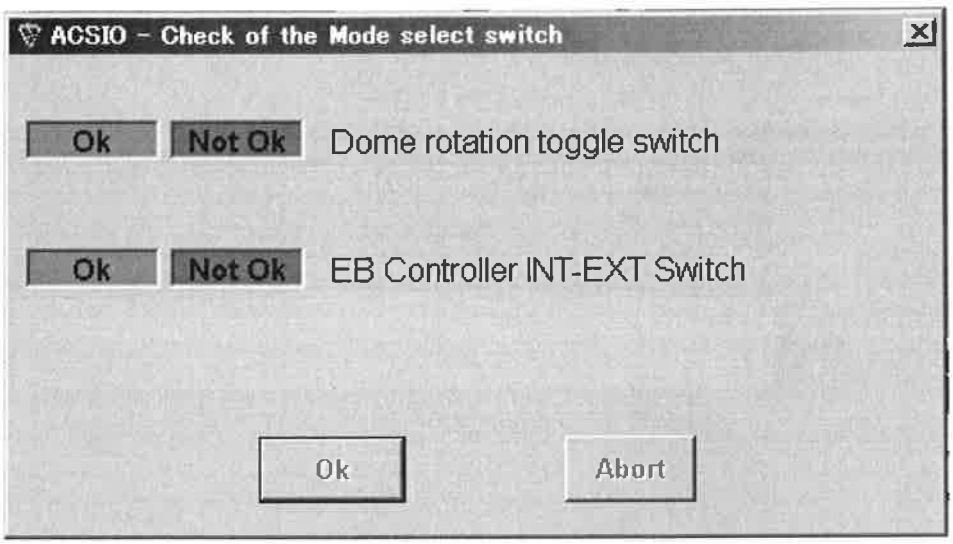


Fig. 46 Evaporation Process - Toggle switch mode check

ACS needs *Dome Rotation* toggle switches set to *Auto*, and EB controller set to *External* mode.

ACS will pause here if any of the conditions are not met.

4.2.5 EB Filament annealing

EB Filament annealing will be performed if such settings are made in the Main User Interface (Fig. 4). If the EB filament anneal checkbox is checked (Fig. 4), annealing will be carried out according to annealing setting time.

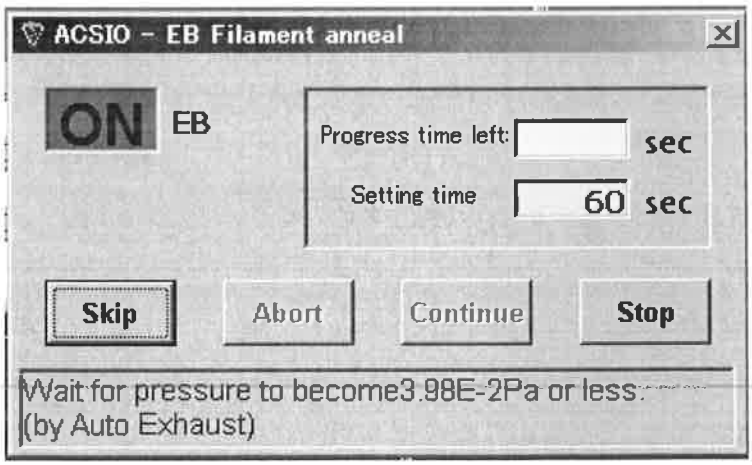


Fig. 47 Evaporation - EB Filament Annealing

Note 7: Annealing processing and vacuum.

Annealing can only be performed if vacuum pressure is less than 3.98E-2Pa.
If *Exhaust Mode* of PLC is set to *Manual*, annealing will not be carried out either (please switch *Exhaust Mode* to *Auto*).

4.2.6 Check Start Conditions

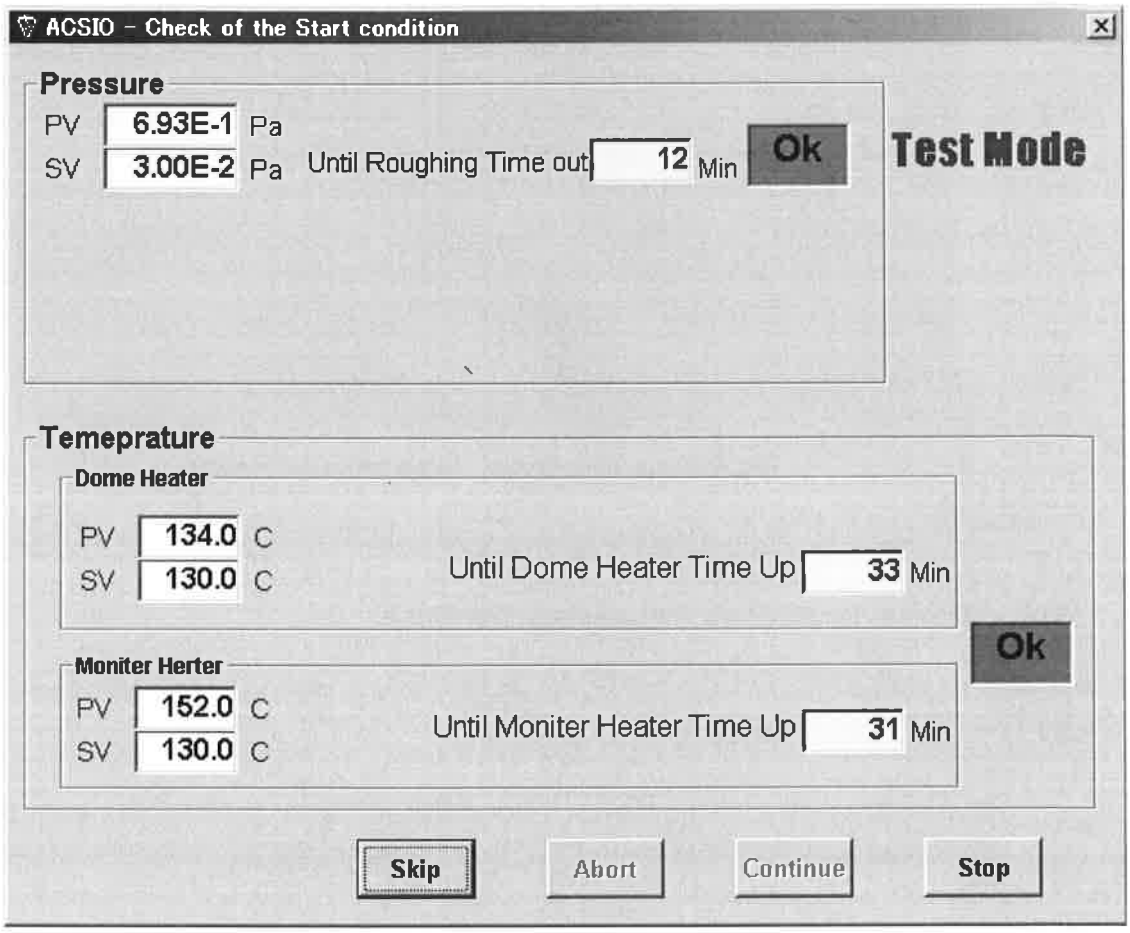


Fig. 48 Evaporation Process - Check start conditions

Pressure and temperature conditions will be checked. The OK part in Fig. 48 will be turned green if respective conditions are satisfied.

Under *Test* mode, there will be a Skip button available to skip this step.

If all of the conditions are met, evaporation process will automatically proceed to next step.

4.2.7 Monochrometer Initialization

This step of Monochrometer Initialization consists of three procedures:

- Hardware initialization (of monochrometer)
- Go to limit position (wavelength)
- Go to standard position (usually 725 nm as shown in

This step can be skipped according to settings in the Main User Interface (Fig. 4), while this is NOT

recommended for processes starting from the first layer.

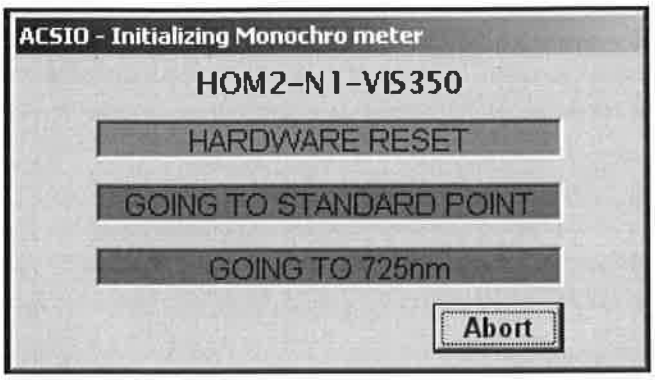


Fig. 49 Evaporation Process - Monochrometer initialization

4.2.8 APC Pressure Check

In addition to APC pressure check, PID parameters are also sent to APC controller simultaneously in order to stabilize target APC pressure in a steady and fast way.

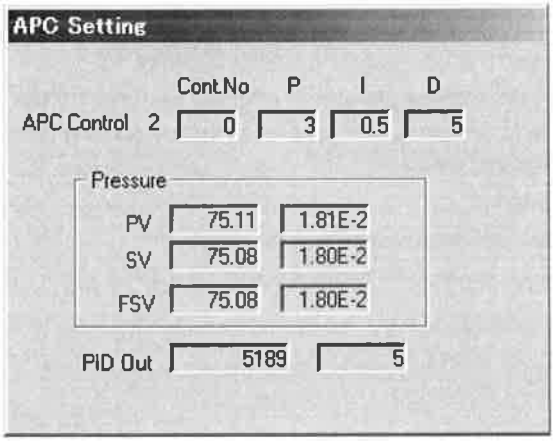


Fig. 50 Evaporation Process - APC pressure check

4.3 Evaporation of a Layer

A typical picture of evaporation presented by ACS is shown below in Fig. 51:

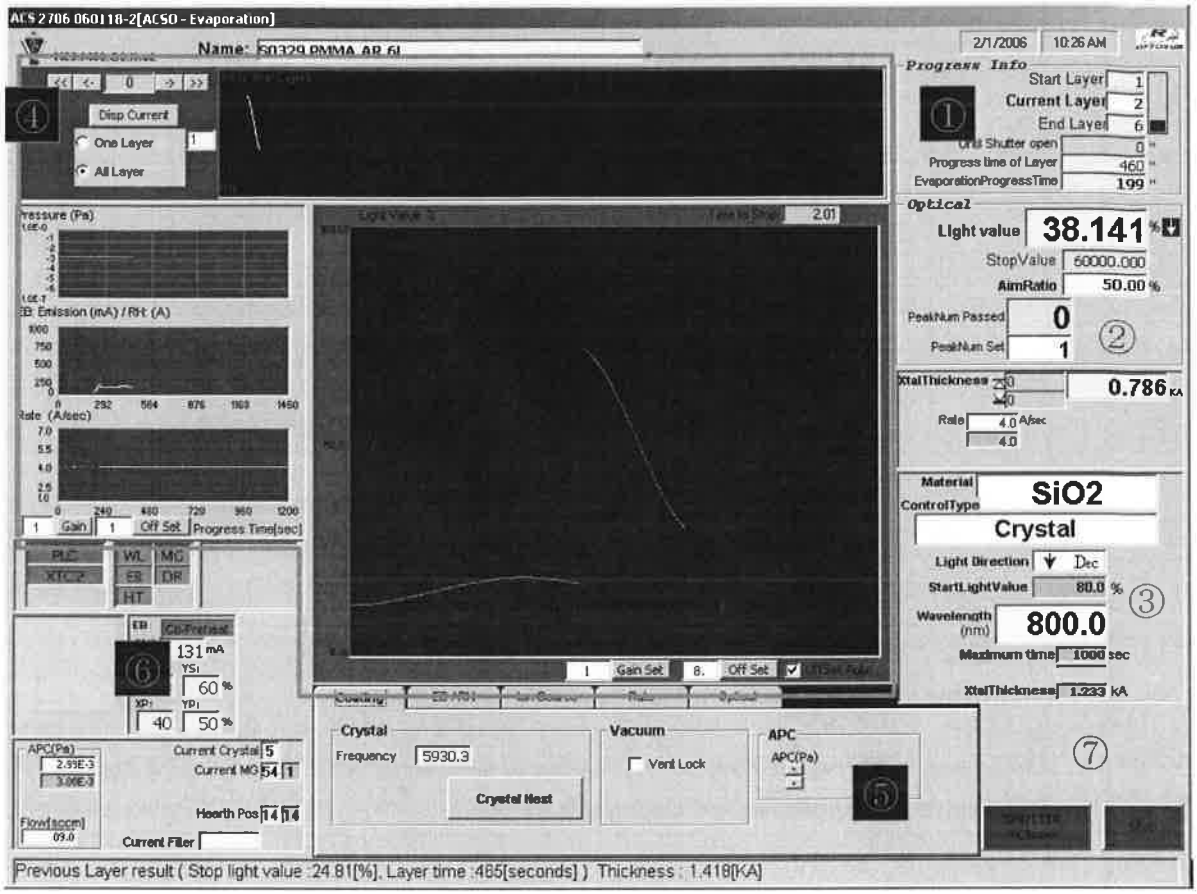


Fig. 51 Evaporation

There are 7 main areas in Fig. 51:

① Layer status
② Optical light value related values
③ Layer parameters
④ Data Graphs (curves)
⑤ Operation panels for EB, optical etc.
⑥ Indicators for status of machine parts
⑦ Command buttons

4.3.1 Layer Status

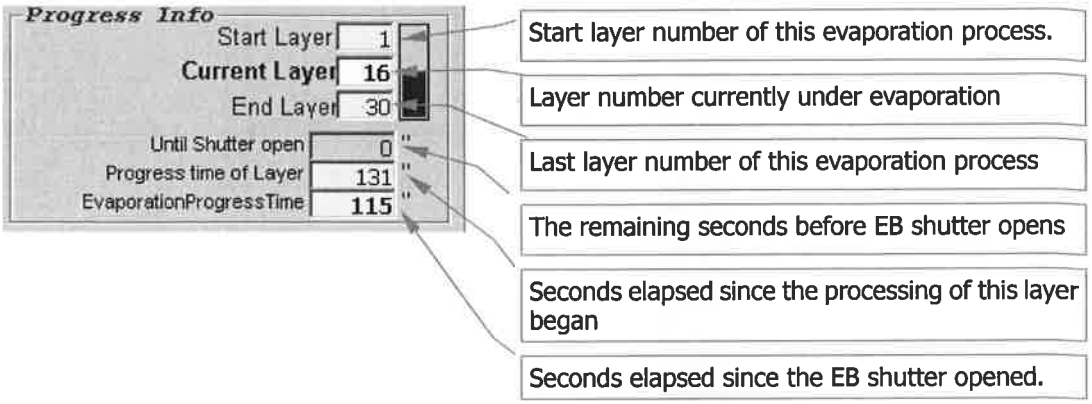


Fig. 52 Evaporation - Layer Status

4.3.2 Optical Light values

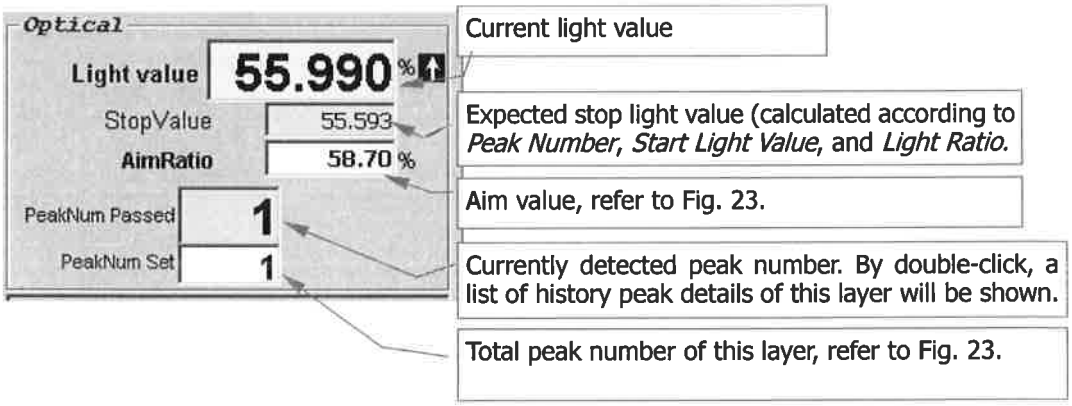


Fig. 53 Evaporation – Optical Light Values

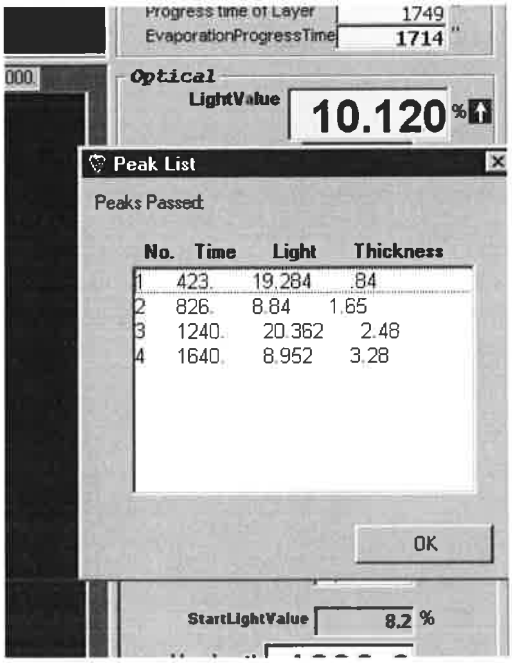


Fig. 54 Evaporation - List of currently detected peaks

4.3.3 Layer Parameters

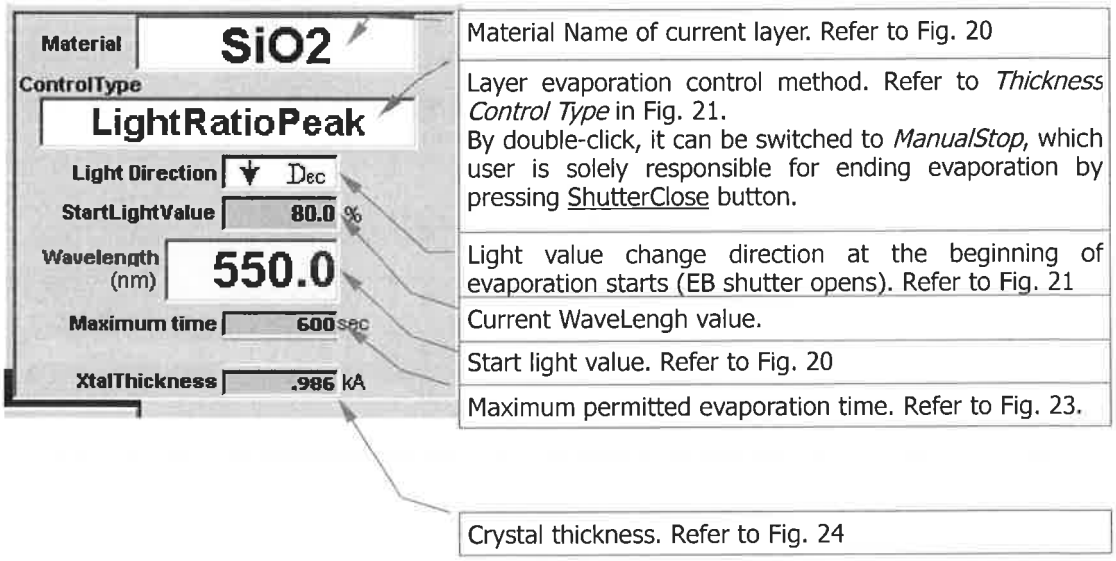


Fig. 55 Evaporation - Layer Parameters (1)

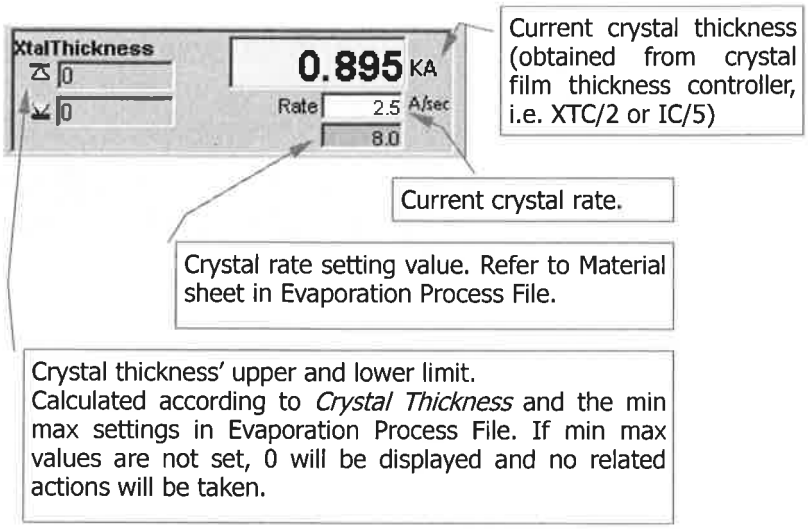


Fig. 56 Evaporation - Layer parameters (2)

4.3.4 Graphs

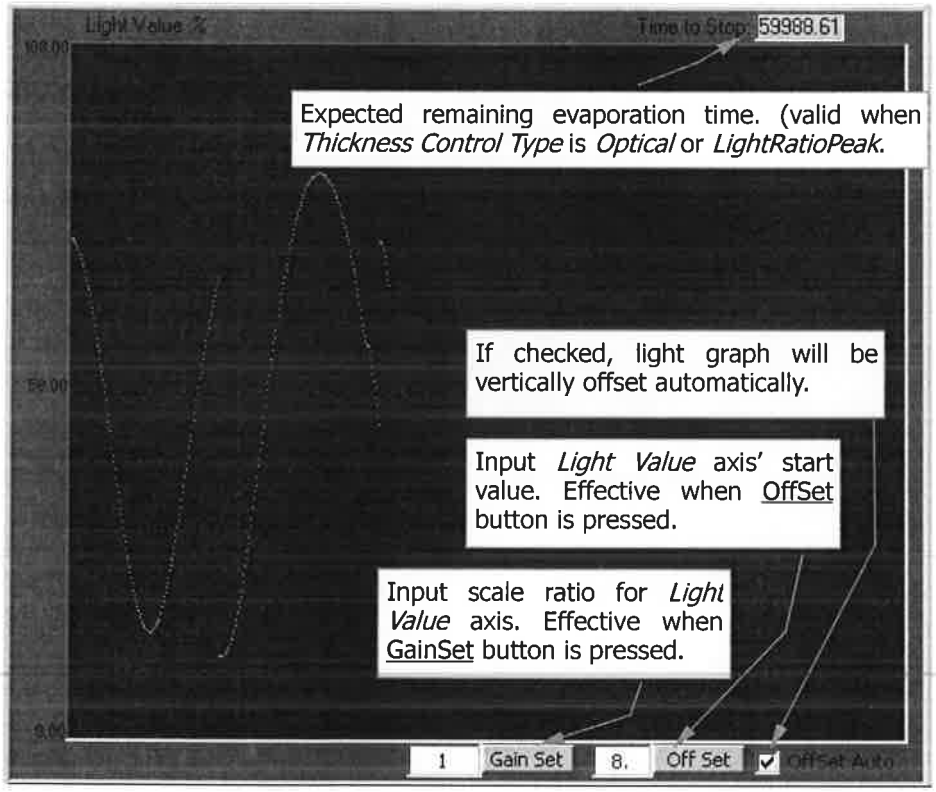


Fig. 57 Evaporation – Graph: Pressure, EB emission, Rate

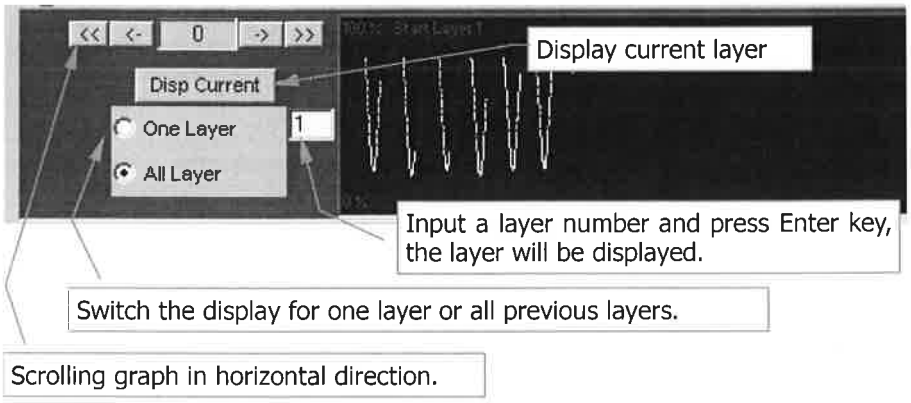


Fig. 58 Evaporation – Light Graph Overview

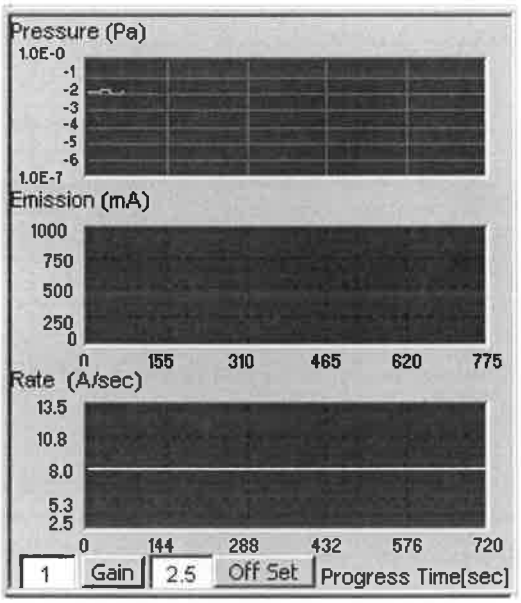


Fig. 59 Evaporation – Graph: Pressure, EB emission, Rate

Vacuum pressure emission current graphs are recorded from the beginning of a layer. Rate graph starts from the minute when EB shutter opens.

4.3.5 Operation Panels for Evaporation

This parts details ⑤ of Fig. 1.

■ Coating Panel

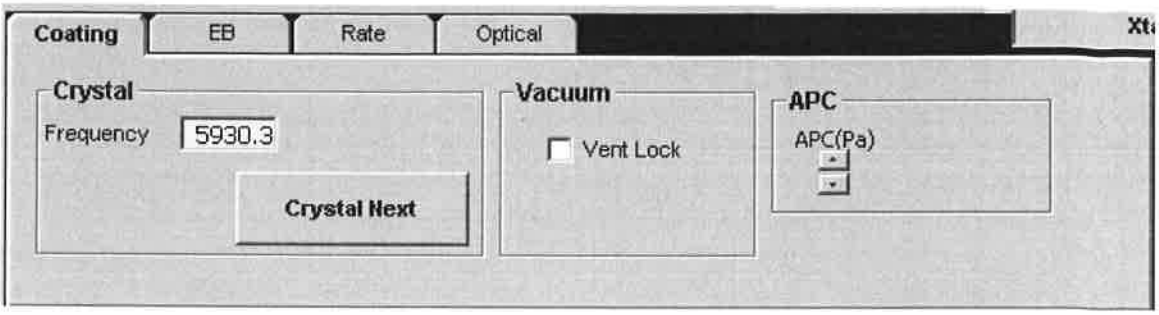


Fig. 60 Evaporation – Coating panel

Crystal:

Frequency:

Displays current crystal frequency. This value is retrieved from crystal film thickness controller (usually XTC/2 or IC/5).

Crystal Change:

If Crystal Change button is pressed, crystal sensor will be moved to next position.

Attention 7: Crystal Change

If current crystal sensor is the last one (e.g. the 6th sensor in a Crystal Six system), crystal sensor can NOT be changed even if Crystal Change is pressed.

Crystal Change button can be used only when evaporation starts.

Vacuum:

Vent Lock

If Vent Lock is checked, chamber will be maintained in high vacuum status after a batch's coating finishes.

If Vent Lock is NOT checked, vent operation will be automatically performed after coating finishes.

APC'

Setting can be modified by using .

■ Electron Beam

This panel contains operation units for EB tuning.

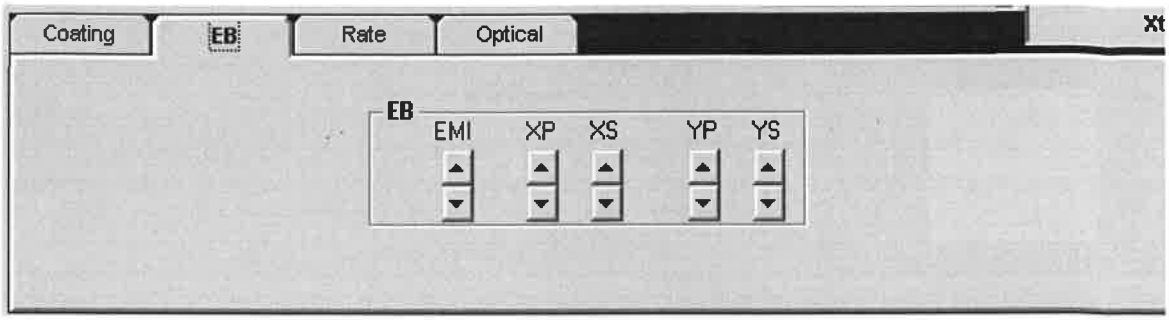


Fig. 61 Evaporation - EB panel

On this panel, the following EB values can be tuned during evaporation (by use of the related button):

- EMI: EB emission current value.
- XP: X position
- XS: X scan
- YP: X position
- YS: Y scan

■ Rate

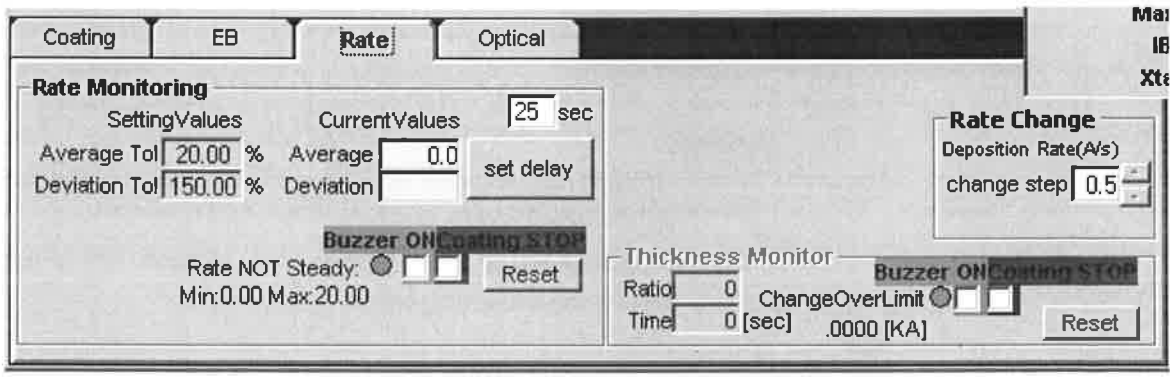


Fig. 62 Evaporation - Rate panel

Through this panel, the following operation can be performed:

- Rate setting modification
- Rate fluctuation stability monitoring
  Buzzer alarm and coating stop can be performed when rate stability abnormality occurs. Refer to 9.2 for specifications.
- Thickness Monitoring
  During evaporation, if the amount of thickness change within a specified period of time exceeds setting limit, buzzer alarm or stop action will be taken.

Note 8: effectiveness of tuning operation when process is undergoing

Any modifications made under an ongoing evaporation process will be applicable ONLY to that specific layer. A new layer will always apply its settings in Evaporation Process File before it starts.

■ Optical Panel

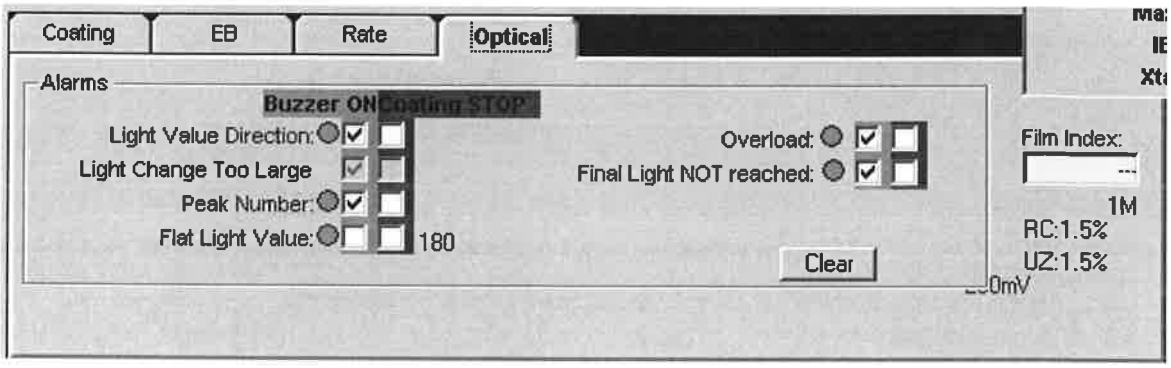


Fig. 63 Evaporation - Optical panel

Optical panel contains mainly error processing operations for optical signal check.

- Light Value Direction
  Current light value is changing against theoretically expected direction.
- Light Change Too Large
  Changes of light value signal has exceeded setting limit within setting period of time.
- Flat Light Value
  Change of light value signal has been less than *Undetected Zone* within a specified period of time.
- Peak Number
  Detected *Peak Number* has been greater than setting value (Fig. 22)
- Overload
  Light value signal exceeds permitted value according HOM (optical film thickness monitor)
- Light Value Can Not be Reached
  Condition for this error is :
  ① *LightRatioPeak* thickness control type is used,
  ② Detected peak number has been greater than layer's setting value (Fig. 22) while the *Aim Value* (Fig. 22) can not be reached.

  This usually means unexpectedly low-level value of peak in an actual coating process.

If *Coating Stop* is not checked for this option, evaporation will automatically proceed to next layer immediately after this error is detected.

Film Index:

This displays film index calculated according to light values of the current layer.

Conditions for correct film index calculation is:

- Current layer starts from using a brand new monitor glass.
- The first peak is detected (and film index value will be shown from then on)

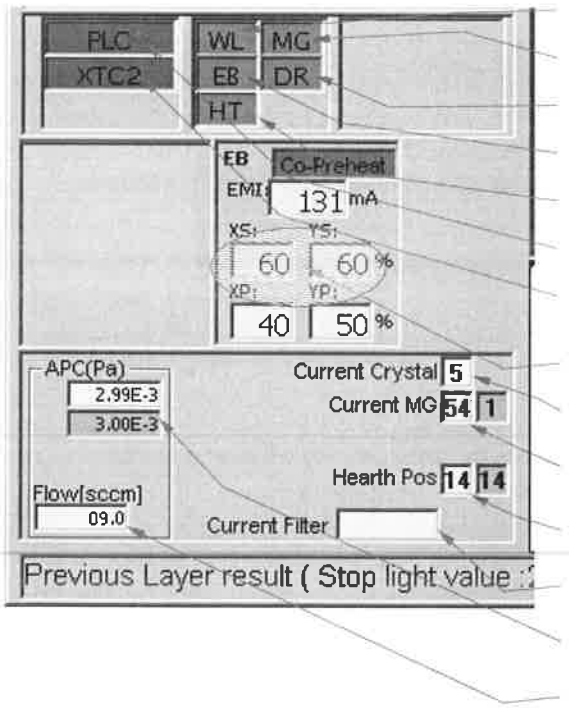
RC, UZ

RC and UZ are *Reverse Change* and *Undetected Zone* values directly retrieved from Evaporation Process File (Fig. 24).

The value with a unit of **mV** (e.g. 500mV) is the sensitivity of HOM. And the value below it is current Pre-Amp's electronic amplification setting value.

These values are for evaporation time reference.

4.3.6 Indicators for Status of Machine Parts



Turned to green if monochrometer is ready
Turned to green if *Monitor Glass* setting is finished
Turned to green if Dome's rotation state is ready
Turned to green if EB is ready
Turned to green if Hearth setting is finished
Turned on if data is being sent to PLC
Turned on if setting values are being sent to XTC/2
EB status (values).
Current *Crystal Sensor* number
Current *Monitor Glass* position. The one next to it is setting value.
Hearth current cup position. The neighbouring one is setting value.
Number ID of filter inside monochrometer
APC current value. The one below it with grayed background is setting value.
Current APC gas flow amount

Fig. 64 Evaporation - Indicators for Status of EB

4.3.7 Command Section

As shown in Fig. 65, there are only two command buttons.

Though in no way frequently used, these two buttons serve import roles for special interruptions during evaporation process:

Fig. 65 Evaporation – Command Section

- Shutter – Close

  If this button is pressed, the currently ongoing layer's evaporation will be finished, and evaporation will continue to proceed to next layer (or the whole batch of coating comes to an end if current layer is the last one).

- Stop

  If this button is pressed, evaporation process will be stopped waiting for further operations from user.

5. Performing Checks

For such parts as *Monitor Glass* and *Crystal Sensor*, there are frequently needs for status checking, especially before coating. Such a knowledge concerning overall status of these parts are essential for a smooth and successful coating process.

This section describes the usage of specially designed functions to fulfill this purpose.

5.1 Monitor Glass Check

To start *Monitor Glass* check, please press Monitor Glass Test button around section ⑥ in Fig. 1.

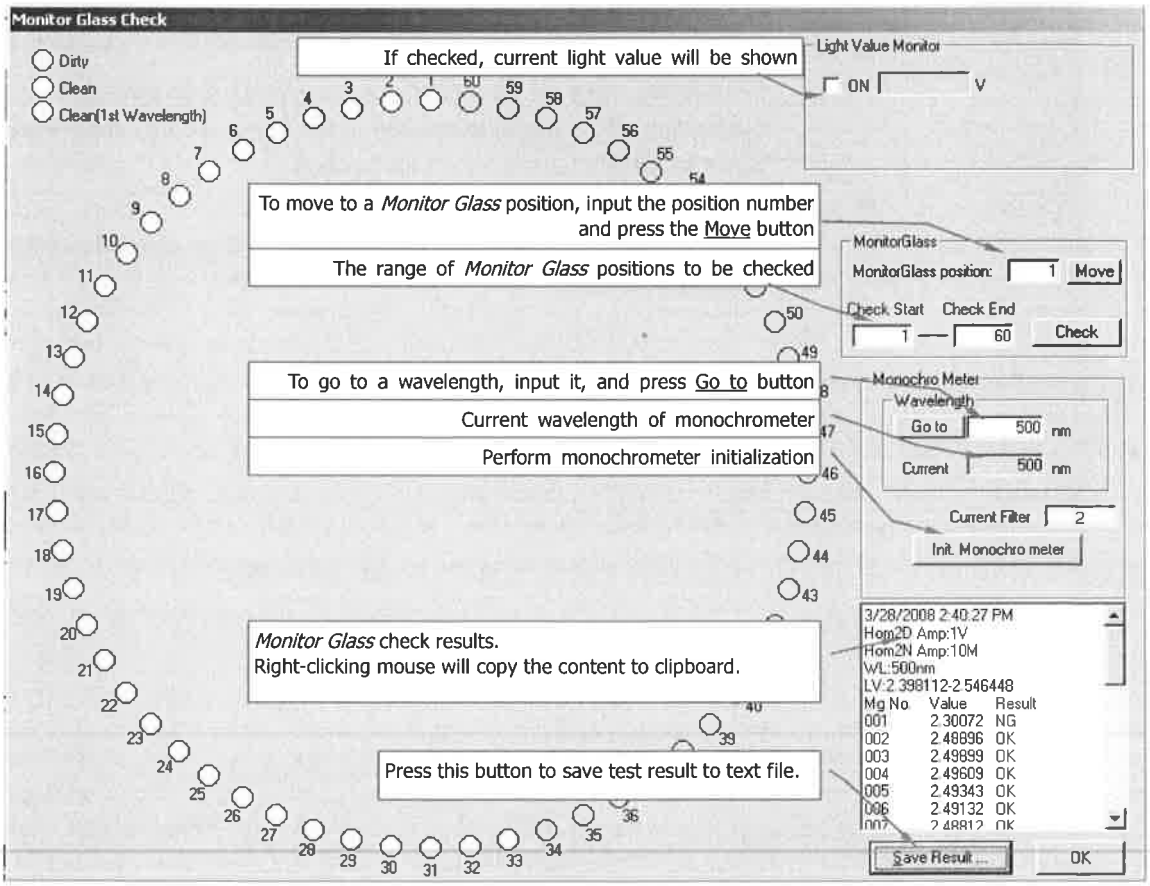


Fig. 66 Monitor Glass Check

Some operations are offered, such as setting of *Monitor Glass* setting and monochrometer.

Press Check button to start a test.

Upon finishing *Monitor Glass* positions inside specified range will be marked in this way:

- White: an unused clean position
- Yellow: a used position

For correct evaluation of usage status of *Monitor Glass* chips, a reference clean position must be specified. And also wavelength under which check is to be performed is also necessary. To go to ACS user interface of these settings, follow the steps:

1. Go to the main user interface, i.e. Fig. 1
2. Press Ctrl, Alt and Shift key at the same time,
3. Right-Click the Monitor Glass Test button

Then a setting interface will pop up.

Save Monitor Glass Test Result

Test result can be saved to test file. To do this please press the Save Result button in Fig. 67. A save result dialog box appears where user can input a filename (by default a filename is automatically created), as shown in the following

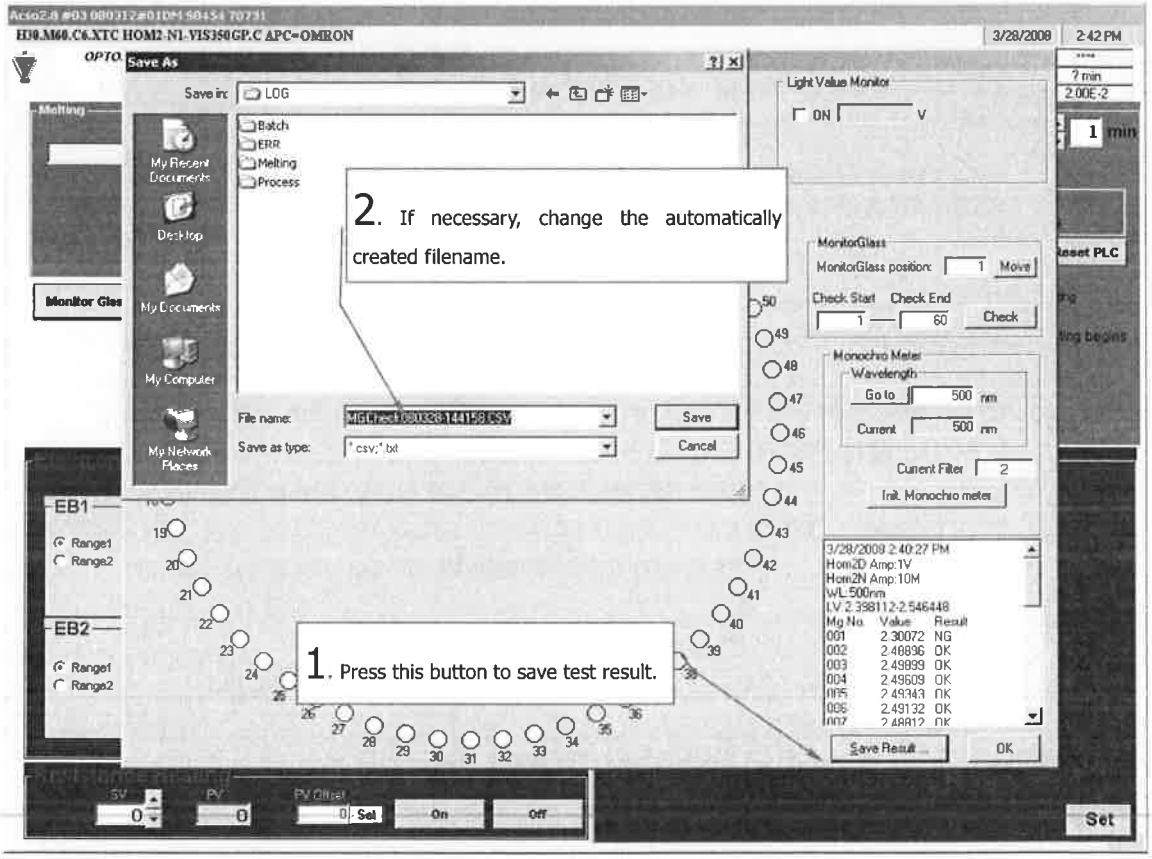


Fig. 67 Save Monitor Glass test result to a file

5.2 Crystal Sensor Check

To start *Monitor Glass* check, please press Crystal Check button around section ⑥ in Fig. 1.

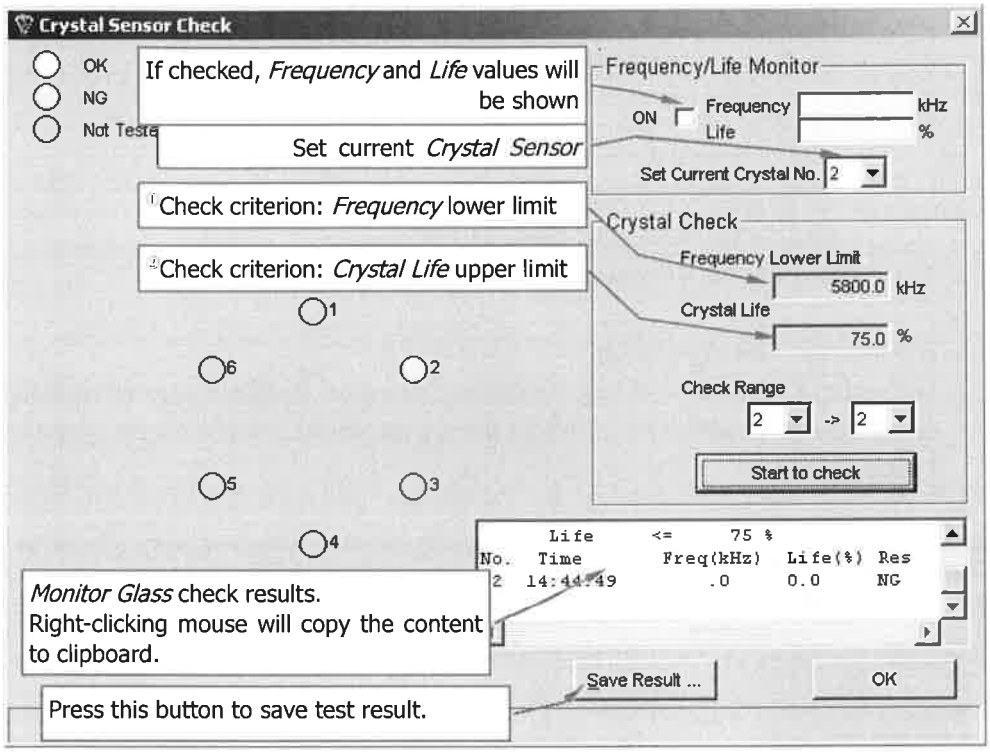


Fig. 68 Crystal Sensor Check

Press Check Start button to start check.

Upon finishing checked *Crystal Sensor* positions will be marked in this way:

- White:
  Sensors regarded as normal (usable) according to prescribed criterions
- Yellow
  Sensors regarded as unusable according to prescribed criterions

Criterion for a "good" (usable) sensor is:

- Frequency > Crystal Sensor Frequency lower limit (Fig. 68)
  And
- Life < Crystal Sensor Life upper limit (Fig. 68)

Change Crystal Check Criteria

For protection purpose frequency and crystal life criteria can not be edited by default. As shown in Fig. 68 ((1),(2)), frequency and life text fields are grayed.
To edit these values, at first press the CTRL, ALT and SHIFT keys and at the same time click the frequency or crystal life text using mouse's left-button. Please refer to

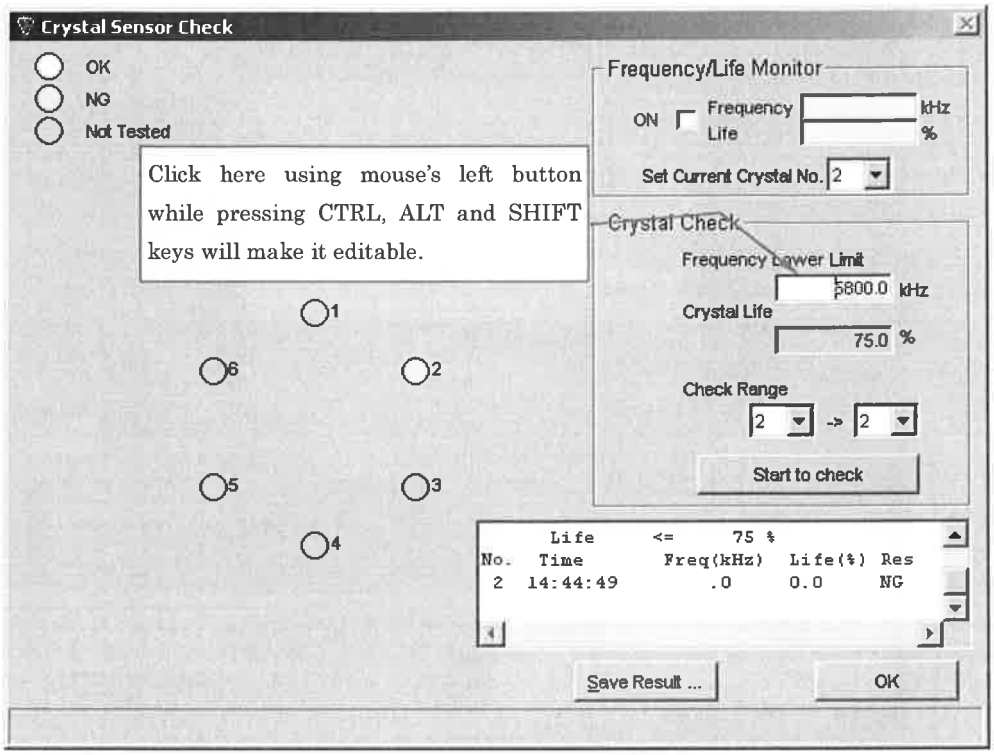


Fig. 69 Edit Crystal Check Criteria

To turn off the "editable" status, repeat the mouse click operation again.

Save Test Result

Test result can be saved to test file. To do this please press the Save Result… button. A save result dialog box will appear where user can input filename (2 in Fig. 70).

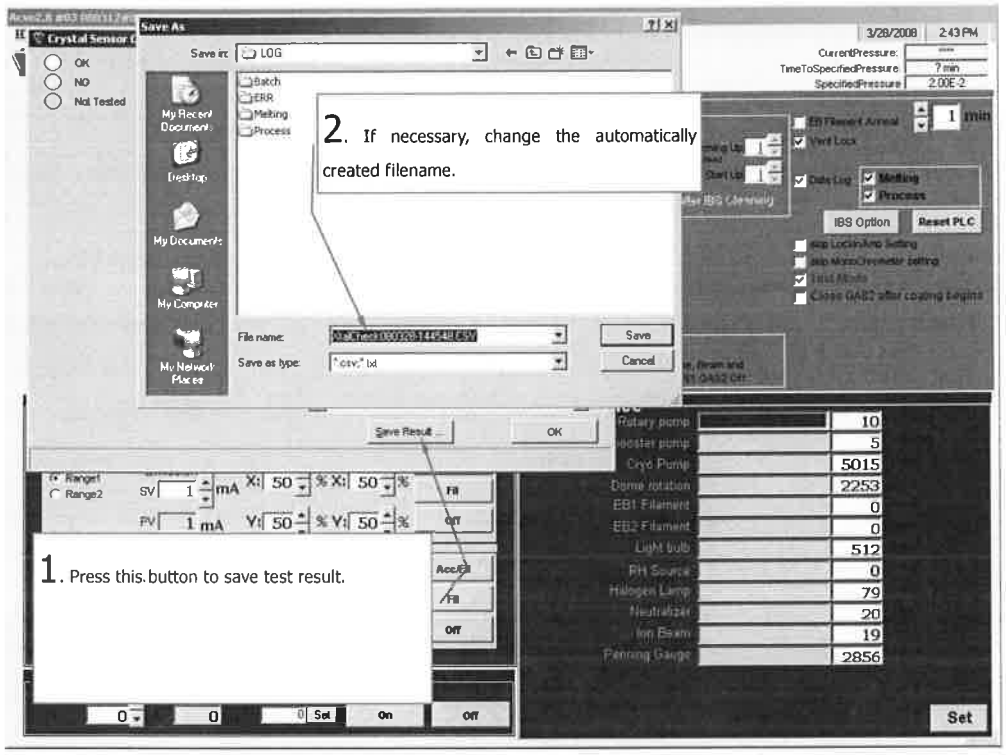


Fig. 70 Save Crystal result to a text file

6. Maintenance

6.1 Maintenance Parameters

The following parts equipped onboard the Optorun's coating machine can be maintained by ACS system:

- Usage time of Rotary Pump
- Usage time of Mechanic Booster Pump
- Usage time of Diffusion Pump
- Usage time of Dome Rotation part
- Usage time of EB's filament
- Usage time of Penning vacuum gauge

6.2 Management of Usage Time

In ⑤ of Fig. 1, usage time are displayed in respective progress bars.

6.3 Setting of Time

6.3.1 Maximum Time

The maximum time indicated by progress bar shown in Fig. 1 ⑤ can be set in this way:

1. Press Set button in Fig. 1
2. The following Fig. 71 will pop up and maximum time can be set.
3. When completed, please press the OK button.

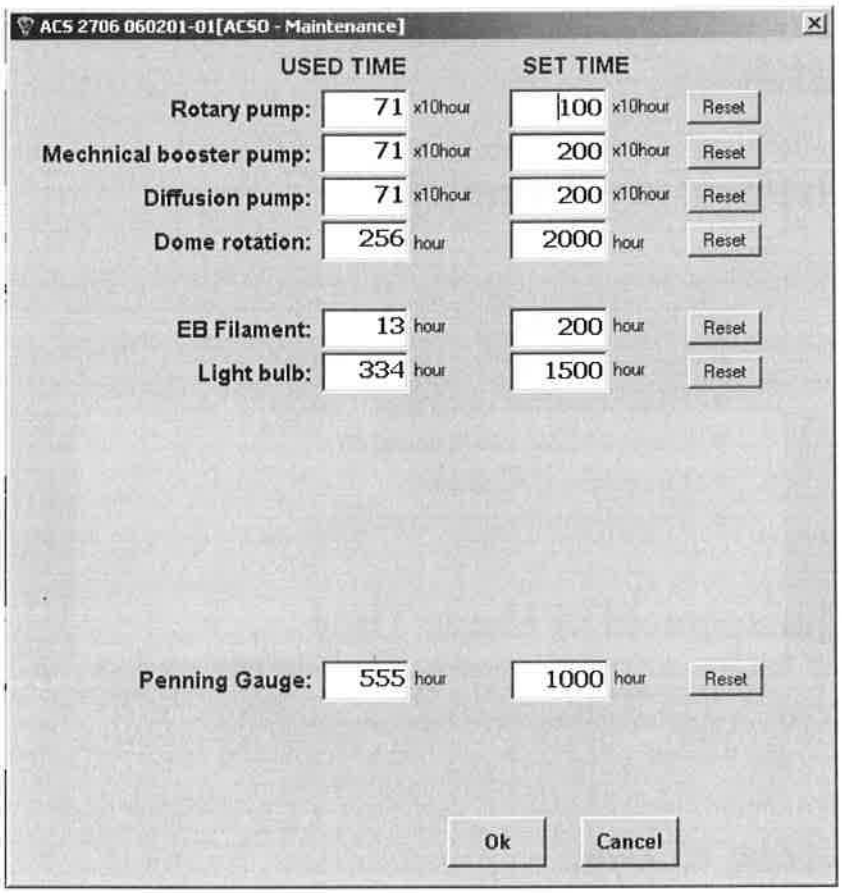


Fig. 71 Maintenance Time Setting

6.3.2 Usage Time Reset

Usage time recorded by system can be reset, i.e. forcibly set the *Usage Time*'s to 0.
The operation method is:

1. In Fig. 71, press the Reset button
2. When completed, press the OK button

7. Alarms and Solution

7.1 Restore from Troubles

Whenever evaporation process is stopped due to abnormity, error or user interruption (Fig. 65 Stop button), the following Fig. 72 will pop up:

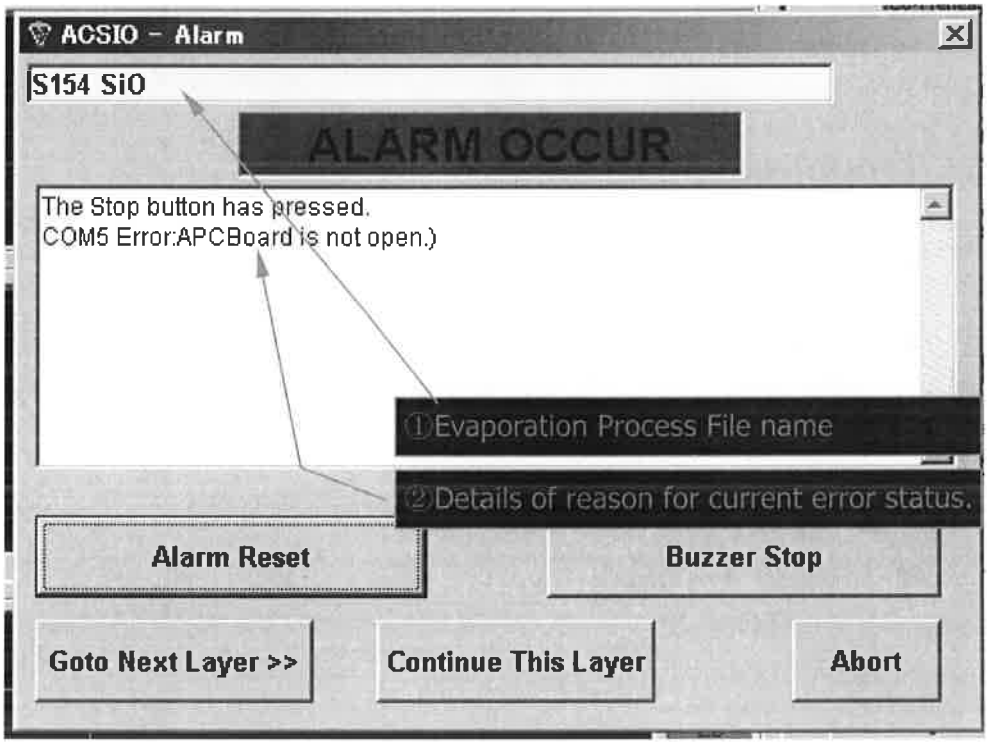


Fig. 72 Alarm User Interface

7.1.1 Recover From Error

To restore from abnormal state (shown as Fig. 72), follow these opterations:

1. Press Buzzer Stop button
2. Refer to ② in Fig. 72 for detailed description of error, and do what is necessary to recover from errors;
3. Press Alarm Reset button to clear error state from ACS system.
   If trouble has not yet been removed, error status remains despite actions of Alarm Reset.
4. If user decides to proceed to next layer's evaporation, press the Goto Next Layer button.
   (this option is only available for Evaporation Process.)
5. If user decides to continue current layer's evaporation, please press the Continue This Layer button.
   This option is only available for Evaporation Process. For Melting Process, there is only Continue button available.
6. If user decides to stop current process, please press Stop button, which will result in exiting back to

the main user interface Fig. 1.

Note:

For Evaporation Process, Evaporation Process File name will be shown as in Fig. 72's ①.
If necessary, user can edit the Evaporation Process File by double-clicking it.

7.1.2 Recover from Abnormal Exit of ACS

If ACS exited abnormally, i.e. by ways other than pressing the Exit button in Fig. 1, please follow the next steps:

1. Please restart computer,
2. Start ACS
3. Press the PLC Reset button located at right side of Fig. 1.

7.2 Troubleshooting Guide

Here is a list for troubleshooting refernce:

- Message: EB ACC / FIL
  Explanation: EB's ACC and Filament is not at ON status.
  Cause 1: EB's interlock is not ON.
  Cause 2: EB filament is broken.
  Cause 3: EB's EXT-INT switch is not set to EXT. mode

- Message: EB ACC
  Explanation: EB's ACC voltage has gone beyond setting range (Refer to Fig. 10③ and Fig. 32).
  Cause 1: Setting of ACC voltage upper limit or lower limit is not correct(Refer to Fig. 10③ and Fig. 32).
  Cause 2: EB does not function normally.

- Message: EB Emission Current
  Explanation: EB Emission Current is far below setting value.
  Cause 1: EB Filament is broken.
  Cause 2: EB's EXT-INT switch is not set to EXT. mode
  Cause 3: EB does not function normally.

- Message: EB Remote
  Explanation: EB's EXT-INT switch is not at EXT. mode.
  Cause 1: EB's EXT-INT switch is not set to EXT. mode

- Message: APC Gas Pressure
  Explanation: APC Pressure is below the limit level set in Evaporation Process File (Fig. 22).
  Cause 1: Valve on GAS container is not turned on (which prevents GAS induction into vacuum chamber).
  Cause 1: GAS container exhausted.

■ Message: Machine Alarm
Explanation: Abnormal status happened.
Cause 1: Various causes are possible; please refer to operation manuals of related parts of coating machine.

8. General Operation Instructions

For proper operation of the ACS system, please pay attention to the following instructions:

Note:

If no further explanation is made, the word *computer* used here is referred the computer that is equipped onboard Optorun's coating machine on which ACS system is run.

- Please do NOT use *Screen Savers*, which will result in unexpected troubles for process operation;
- Please do NOT install unrelated software applications on the computer ACS is running on. Their interference might prevent ACS from working normally;
- Please do NOT install unrelated hardware accessories on the computer ACS is running on. Their interference might prevent ACS from working normally;
- Please manage the computer's account (user name and password) carefully. Logon failure with correct user might lose access to data in hard disk;
- Please do NOT modify names of folder and files used by ACS system. Such changes might result in ACS's functional failure.
- Computer's shutdown / poweroff must be performed in the normal way required by Windows system. The computer might not startup properly due to abnormal termination of Windows system.
- During the time ACS system is running, please do NOT start other software applications on the computer.
- To prevent from troubles of OS and degradation of system performance, please restart the computer at least once a week.
- Periodical backup of user data in the computer is a must.

9. Addendum

9.1 Details of Thickness Control Type

9.1.1 Thickness Control Type List

For Evaporation Process, every layer must specify one of the Thickness Control Types for thickness control (Fig. 21).

The following coating control types are defined:

- Optical

  When using *Optical* control type, ACS controls coating process according numbe of peaks detected from optical light value curve.

  If number of detected peaks reaches setting value (Fig. 22), coating process for that layer is to be finished.

  Notice:

  1. When using the ***Optical*** control method, coating time from coating start to when the first peak arrives or between two successive peaks must be more than 30 seconds.
  2. There is possibility that false peak prediction is made or failure to detect true peak according to electrical/optical signals. This method is reliable only when signal is strong enough.

- LightRatioPeak

  When using *LightRatioPeak* thickness control method, ACS will finish a layer evaporation process when light value curve reaches calculated stop light value.

  This stop light value is determined by three parameters set in Evaporation Process File: *Start Light Value*, *Aim Value* and *Peak Number* (Fig. 20 and Fig. 22).

- Time

  When using *Time* thickness control type, ACS will control coating process according to evaporation time.

  If evaporation time reaches the *Maximum Time* parameter set in Evaporation Process File (Fig. 22), evaporation process will be finished.

- Crystal

  When using *Crystal* thickness control type, ACS will control coating process according to crystal thickness recorded by Crystal Thickness Controller (XTC/2 or IC/5).

Target thickness value is the *Crystal Thickness* parameter set in Evaporation Process File (Fig. 23).

- ManualStop

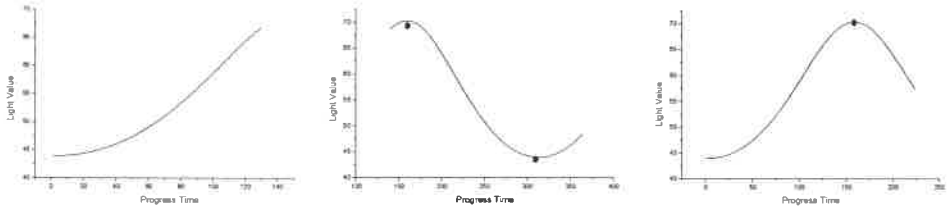
As its name implies, *ManualStop* offers an option for user control of layer thickness instead of automatic control by ACS system.

When using this method, user should press the Shutter Close button in Fig. 65 to finish a layer's evaporation.

9.1.2 *LightRatioPeak* specifications

9.1.2.1 Definition of Peak

Peak refers the turn point in light value cure.
Examples:



PeakNumber = 0 PeakNumber = 2 PeakNumber = 1

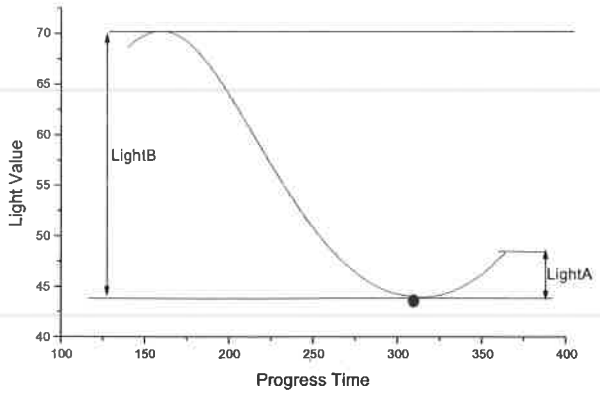
Fig. 73 Peak Definition

9.1.2.2 *AimValue* Calculation

LightRatioPeak method defines a method controlling evaporation process according to light value ratio.

Aim Value (Fig. 22) in *LightRatioPeak* method is calculated in this way (refer to Fig. 73):

AimValue = LightA / LightB



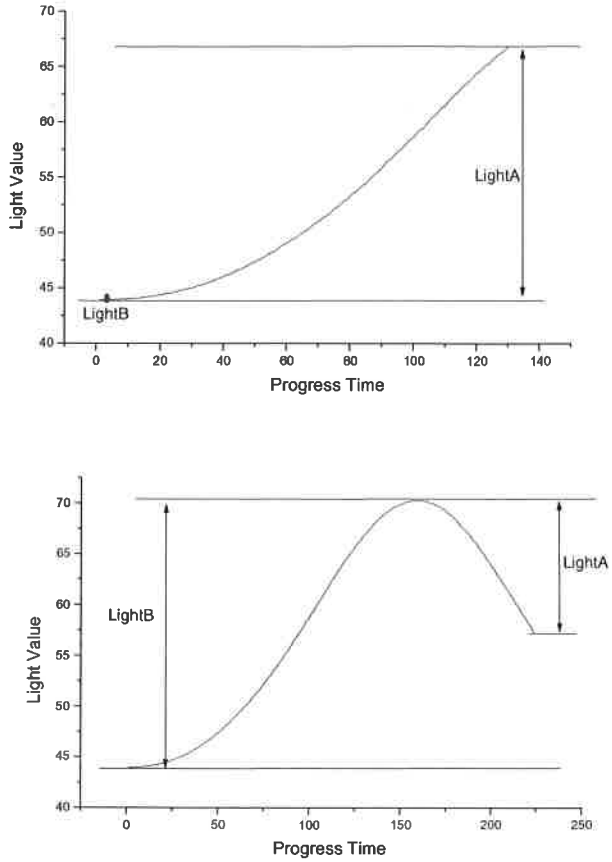


Fig. 74 LightRatioPeak - AimValue calculation

9.1.2.3 Stop position of *LightRatioPeak*

In previous section of 9.1.2.2, method for calculating *Aim Value* is described.

For *LightRatioPeak* control method, a reverse process of the calculation is performed to determine *LightA* in Fig. 74 using these parameters in Evaporation Process File:

- Peak Number
- Start Light Direction
- Start Light Value
- Aim Value

Its is apparent that with these parameters supplied, theoretical stop point of a layer's optical light value is fully determined. This stop point value is calculated and displayed (Fig. 53).

9.2 Deposition Rate Monitoring

Deposition rate is being monitored during coating process (Fig. 62).

Two values are calculated for crystal monitoring: ***Average Rate Error***, and ***Rate Deviation Error***. And ***Average Tolerance*** and ***Deviation Tolerance*** are used for measuring whether rate falls into a range beyond tolerable limits. Both these two limits are set in Evaporation Process File (Fig. 24).

Average Rate Error and ***Rate Deviation Error*** are given by the following formulas:

$$AverageRateError = \frac{|AverageRateValue - SettingRateValue|}{SettingRateValue}$$

$$RateDeviationError = \frac{\left|\sqrt{\frac{1}{n-1}\sum_{i}^{n}(y_i - AverageRateValue)^2}\right|}{AverageRateValue}$$

$$AverageValue = \frac{\sum_{i}^{n} y_i}{n}$$

ACS performs monitoring at intervals of one second. Therefore above formulas are based on data sampled once per second.

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User Manual

MOP

An utility for transferring optical film design parameters from Macleod Runsheet to Optorun Coating Process

Table of Contents

Copyright

Terminology

1. Optorun Process:
   — a file using for deposition control on Optorun's coating machine.
   If no special explanation is made, the following are synonyms:
   - Optorun Process File
   - Process
   - Process File

2. Macleod RunSheet:
   — the design related file exported from Essential Macleod® optical thin film design software.

   If no special explanation is made, the following are synonyms:

   - RunSheet
   - Runsheet
   - RunSheet file
   - Macleod Runsheet

1. Introduction

When an optical thin film design is finished using *Essential Macleod Thin-Film*, a *Runsheet* file can be obtained which contains essential design information for achieving the expected physic properties of an optical thin film.

To actually produce the film using Optorun's coating machine, a separate control *Process* file (which is of MS Excel format) must be prepared and supplied to automatic coating software (ACSN or ACSO) for practicing automatic deposition control, and the Optorun's Process file contains not only complete film design parameters but also various production control parameters.

Some of the necessary information should be imported from the Macleod's *Runsheet* file. And this utility, *MOP* is made to facilitate the making of Optorun's coating *Process* file when a design has been finished using *Essential Macleod Thin-Film* software package.

Note: MOP was previously named Macleod2Process.

2. Terms Used in Optorun's *Process* file

For Optorun's *Process* file the following terms should be noted:

a. Peak Number

In Optorun's *Process* file, peak number is defined to be turning point in signal curve.

Examples,

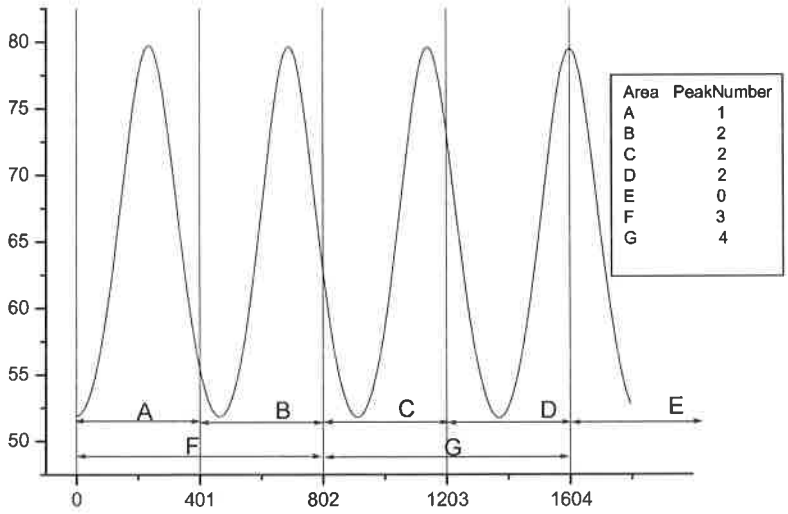

Fig. 1 Examples – definition of peak number for Optorun's Process

Pay attention to the peak numbers in the areas of A, B, C, D, E, F and G:

Tab. 1 Peak number – an example

Area	Peak Number
A (0-401)	1
B (401-802)	2
C (802-1203)	2
D (1203-1604)	2
E (1604-)	0
F (0-802)	3
G (802-1604)	4

Notice:

A signal curve's starting point will ***NEVER*** be considered to a peak (which is different from *Macleod Runsheet*).
Ending point in a signal curve should be regarded as a peak, ***ONLY*** when it is the maximum (or minimum) point.

b. Light Change Direction

In Optorun's *Process* file, *Light Change Direction* is defined as the **starting light direction**, which is the direction of *Increase* or *Decrease* before the first forthcoming peak (if there is any).

c. Start Light Value

Start Light Value refers to the monitoring optical signal value at the starting point of a specific layer. As a matter of fact, it can be any value set by users (i.e. the data value of *Start Light Value* in Optorun's *Process* file).

d. Monitor Wavelength

Refers to the wavelength that the optical film thickness monitoring system is working at when coating process is going on.

e. Monitor Glass

Monitor Glass is the reference glass chip. A new *Monitor Glass* corresponds to a *Chip* in Macleod *Runsheet.*

f. Light Ratio

Refers to the ratio value at the stop point of the monitoring signal. Corresponding to *Final Swing* in Macleod *Runsheet.*

g. Mask

Refers to the *Mask* equipped in Optorun's coating machine. There are totally two masks available for each evaporation source individually.

h. Material

Refers to film material.

i. Control Method

Designating the film thickness control method in Optorun coater's automatic control process.

3. Data Imported from *Runsheet* (Conversion Content)

The following columns in Macleod's *Runsheet* file will be used by *MOP* utility,

a. *Chip* – related to *Monitor Glass* in Optorun's *Process*.
b. *Layer* – related to *Layer No* in Optorun's *Process(**Mandatory**)*.
c. *Design Material* – related to *Material* in Optorun's *Process*.

> ***Note:*** Currently, materials are divided into two kinds, Hi and Lo materials. As user-specific material name can be defined with *Essential Macleod*, user must relate these materials to the materials names (such as H0, H1… and L0, L1…) in Optorun's coating process.
>
> In the case when more than two kinds of materials are being used in *Runsheet* file, user must manually specify appropriate Optorun Process material name for each of the design material name in exported design file.

d. *Monitor Wavelength* – related to *Wavelength* in Optorun's *Process*.
e. *Start At* – related to *Start Light Value* in Optorun's *Process*.
f. *Final Swing* – related to *Aim Value*, i.e. *Light Ratio* in Optorun's *Process*.
g. *Peaks* – related to *Peak Number in Optorun's Process*.
h. *Light Value:* First Min, First Max, Last Min, Last Max, and FinishAt. This is optional.
i. *Physical Thickness:* Physical thickness in *Macleod Runsheet*.
j. *Chip Number:* The recent version of Essential Macleod software can also outputs chip number information. You can choose to transfer this information into Optorun's process file to control the monitor glass use.

The *MOP* utility offers options for users to choose which of these items is to be converted from Macleod's *Runsheet to* Optorun' *Process* file. Refer to the following **Fig. 4 Set conversion options**.

4. Operations

This section explains how to use the *MOP* utility.

It should be emphasized that this utility is designed to facilitate the transferring of film design parameters from *Runsheet* to *Process*. Some of the converted data finally transferred into *Optorun Runsheet* might need user's check for correctness and optimum in respect of deposition technique.

4.1 Prepare Macleod Runsheet file

Before performing the conversion, user must prepare a Macleod *Runsheet* in the format of MS Excel (including .CSV format).

The *Runsheet* can be exported from *Essential Macleod Thin-Film* application, which is usually of CSV format.

4.2 Prepare Optorun coating process file

Before performing the conversion from Macleod *Runsheet* to Optorun's *Process*, a template *Process* file must be prepared as target file for the conversion utility *MOP* to write to.

Note: Original contents of this target ***Process*** file will be overwritten by *MOP* software.

4.3 Perform the conversion

After starting the *MOP* utility program, please follow the following steps for converting operation,

4.3.1 *Step 1*. choose the Macleod *Runsheet* file

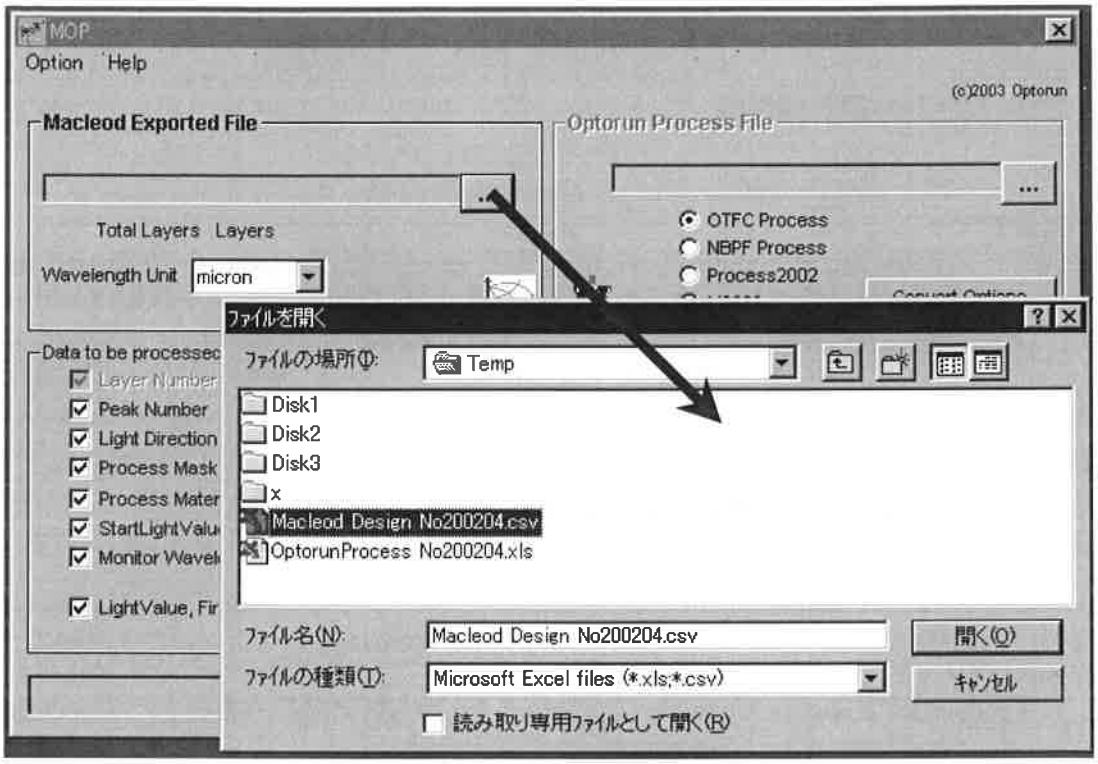

Fig. 2 Choose Macleod Runsheet file

4.3.2 *Step 2.* choose *Optorun Process* file

Attention: **Contents of the selected file will be overwritten.**

Note: Optorun Process file includes macros for maintenance purpose. **You are required to allow these macro to run**:. To do this, you can set the Macro security level to "Low" in MS Excel's *Options* menu.

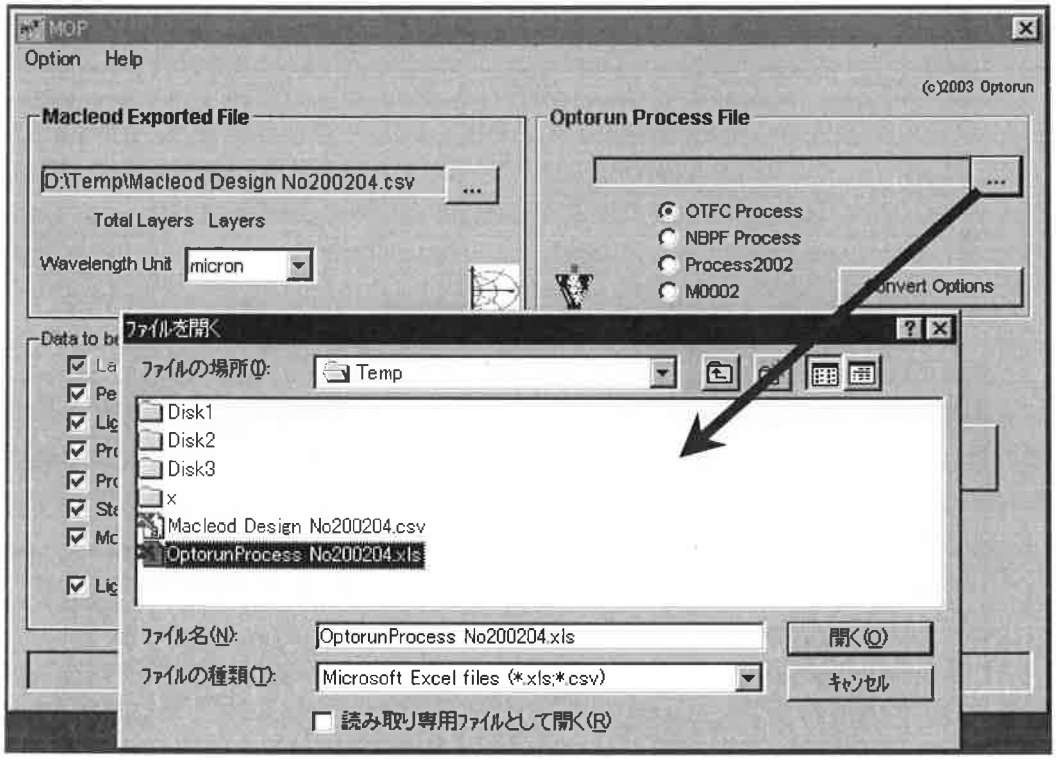

Fig. 3 Choose Optorun' Runsheet file

4.3.3 *Step 3.* set options – items to convert from *Runsheet* to *Process*

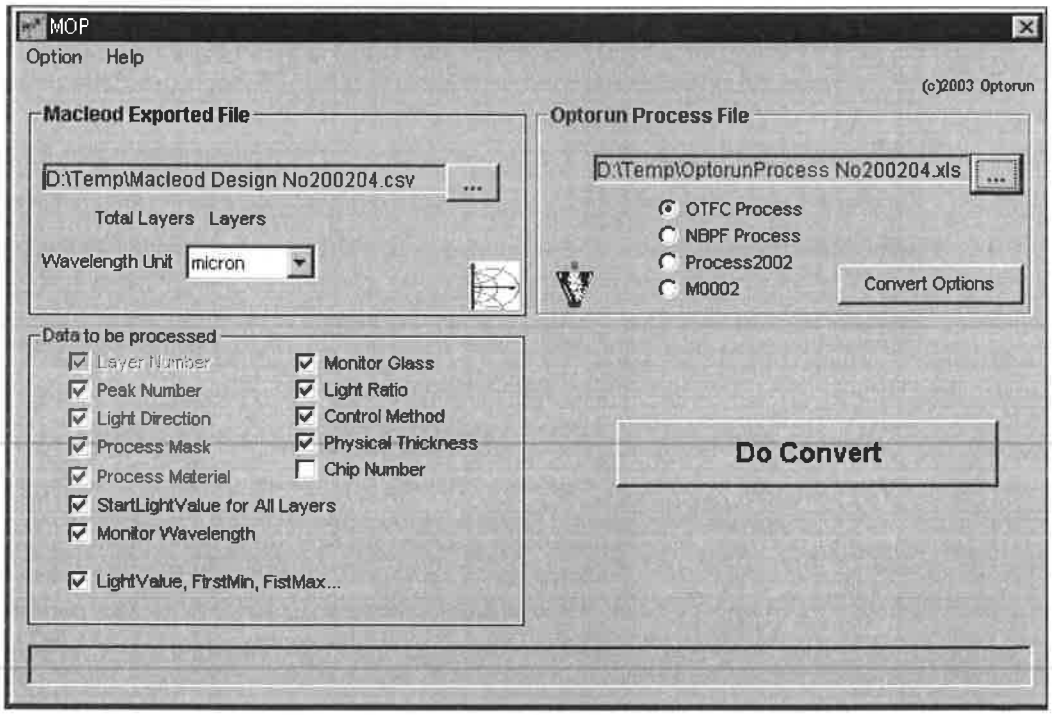

Fig. 4 Set conversion options

Note: The option ***Physical Thickness*** corresponds to the ***Crystal Thickness*** in the runsheet of Macleod design. By selecting this option (only available to OTFC machine), the ***Crystal Thickness*** will be transferred to the ***Physical Thickness*** column in Optorun's process file, which can be used to automatically calculated the ***Maximum Time*** of a layer's coating process.

4.3.4 *Step 4.* set options – Conversion options

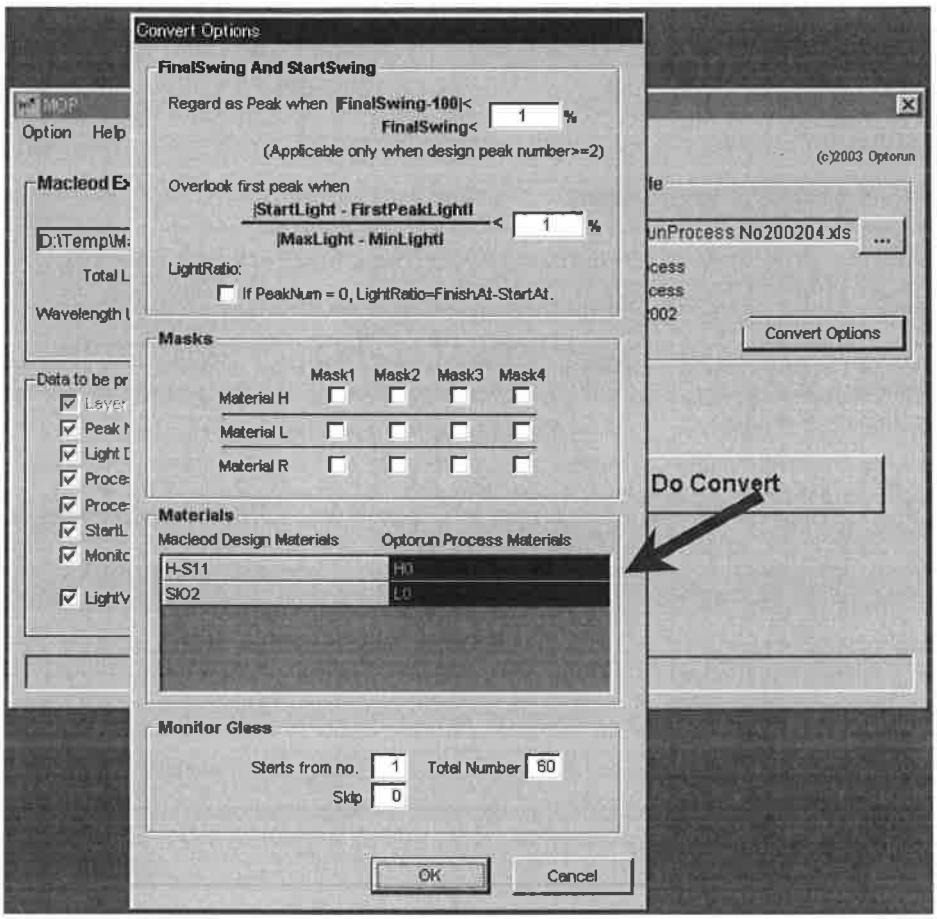

Fig. 5 Set Conversion parameters

a. FinalSwing and StartSwing

i. FinalSwing approximation

The option is "Regard as Peak when |FinalSwing –100|< or FinalSwing<" setting value, i.e. if the conditions are met, the stop point will be approximated as a peak.

Note: This option is only applicable to those layers whose design peak numbers are equal to or greater than 2.

This option is offered for reliable control (see section 5. Check conversion results). When the stop point is approximately the peak (maximum or minimum), it is hard to control to control by using Light Ratio control because it is well possible beyond the control accuracy of the monitoring system. In this case, it is advisable to approximate the last stop point to a *peak*, i.e. a maximum/minimum signal point.

You can actually disable this option by setting it to an extremely small value.

Note:

Pay attention to the effects of the peak approximation – equally to say that a layer designed to use *LightRatioPeak* control method will instead use *Optical*.

If the n*th* layer's FinalSwing is 99.5% and *FinalSwing approximation* setting is 1%, the n*th* layer's coating will be stopped at a peak point. And if the n+1 layer uses the same monitoring glass as that of the n*th* layer, this approximation results in the following change of optical monitor signal curve of the next layer:

a. the next layer's light direction might be inversed
b. peak number of the next layer should be reduced by one.

This case share something in common with the situation described in 5 Check conversion results.

ii. StartSwing approximation

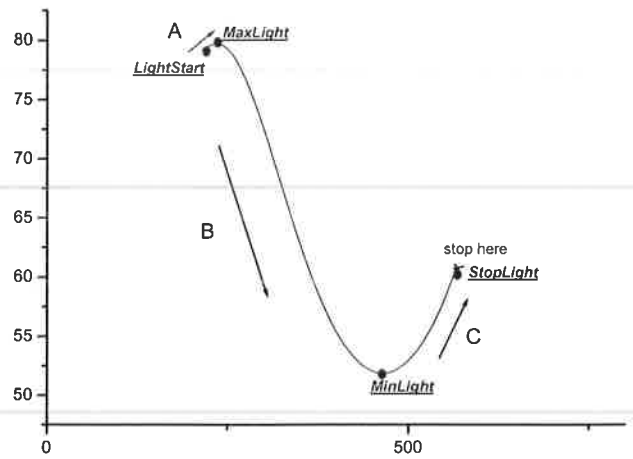

Fig. 6 StartSwing approximation processing

StartSwing is defined as:

$$StartSwing = \frac{|StartLightValue - FirstPeakLightValue|}{|MaxPeakLightValue - MinPeakLightValue|}$$

According to the situation described in **Fig. 6 StartSwing approximation processing**, if the ***StartSwing*** is too small, it is advisable to **overlook** the first peak and accordingly approximately regard start light direction as the opposite (to original design). This option gives the choice of specifying a lower limit of ***StartSwing***, and once it is satisfied *MOP* will automatically change start light direction and decrease total peak number by 1(A similar description can also be found at 5 Check conversion results).

Note: ***This approximation might change the LightRatio (FinalSwing in Macleod design)***

See **Fig. 6**, if the first peak (first Maximum light value) is overlooked, then the ***new*** LightRatio will be:

$$LightRatio_{new} = \left|\frac{StopLight - MinLight}{StartLight - MinLight}\right|$$

And especially if the *StartSwing* approximation results in *zero* peak, that is the only peak in design is overlooked, the LightRatio will be changed to:

$$LightRatio_{new} = \left|\frac{StopLight}{StartLight}\right|$$

b. LightRatio

If PeakNum=0, LightRatio=FinishAt-StartAt

If this choice is checked, *LightRatio*, or the *AimValue* in Optorun's Process file will be calculated as:

LightRatio= abs(FinishAt - StartAt), (when PeakNum = 0)

Attention:

1. If user's **ACSO** is a version that treats Process file's *AimValue* as the difference between start light value and stop light value when peak number is zero, user **must** check this option, otherwise user has to manually edit Optorun Process files's *AimValue* fields whose corresponding layers' *PeakNumber* is zero.

2. If user's **ACSO** does **NOT** specially process *AimValue* in the case of zero peak number, please do **NOT** check this option.

c. Masks

You should specify Mask options if necessary.

d. Materials

Left column lists all the materials found in your *Runsheet* file. What you should do is to correspond each of these materials to the available materials in Optorun's Process file.

To accomplish this, just click mouse over that material, and a popup window appears and choose the material you need.

See the following **Fig. 7 Assign appropriate materials**:

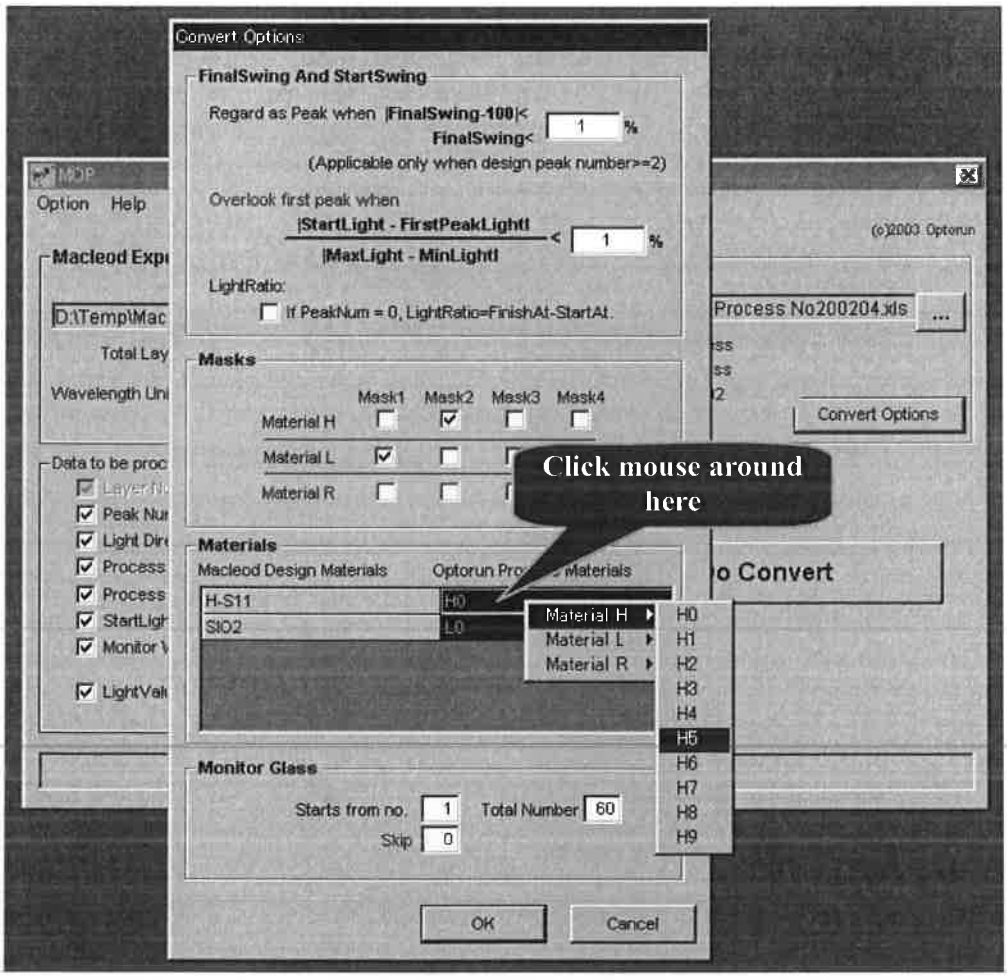

Fig. 7 Assign appropriate materials

Refer to *Design Material* – related to *Material* in Optorun's *Process*.

e. Monitor Glass

i. *Starts from No.*
Input starting Monitor Glass number (Optional) in the field named *Starts from No.* This option is for user to set which point of to start for this *Process*. Default the starting monitor glass is 1.

ii. *Total Number* means the total monitor glass number. Optorun's coating machine is usually equipped with monitor glass of 45 points, 60 points and so on..

iii. *Skip* means when changing monitor glass, how many monitor glass you want to skip. For example, you might want to use in this way, 1, 3, 5…, then you skip ***1*** monitor glass, and if it is 1,4,7,…, the skip value is ***2***. And if you use monitor glass consecutively, 1,2,3,4.., your skip value is 0.
The default skip value is 0.

4.3.5 Step 5. Do the conversion

Press the "***Do Convert***" button to start the conversion process.

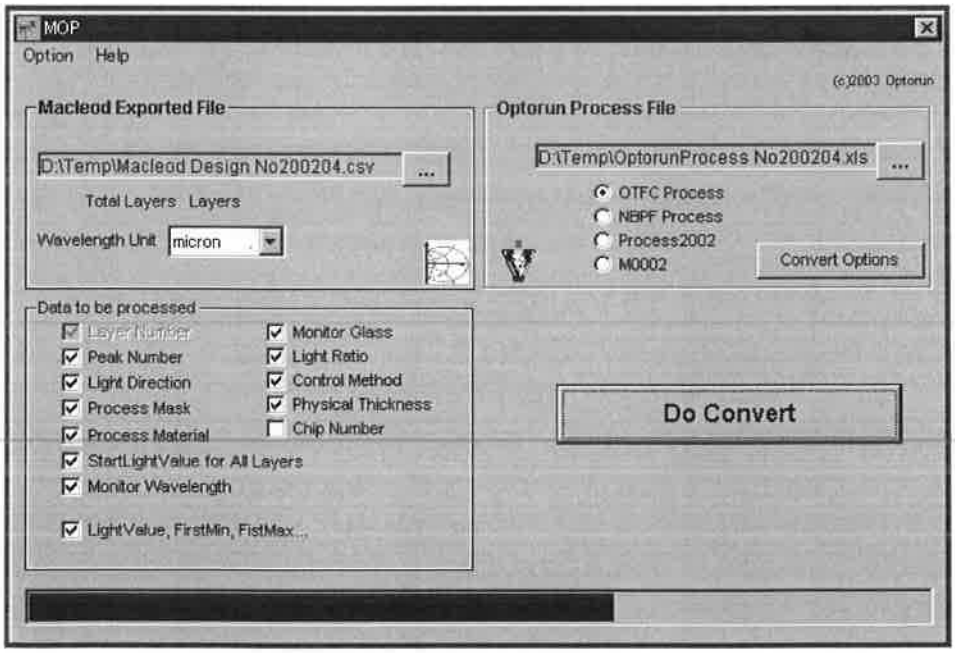

Fig. 8 Converting in progress

Then please wait until the conversion finishes:

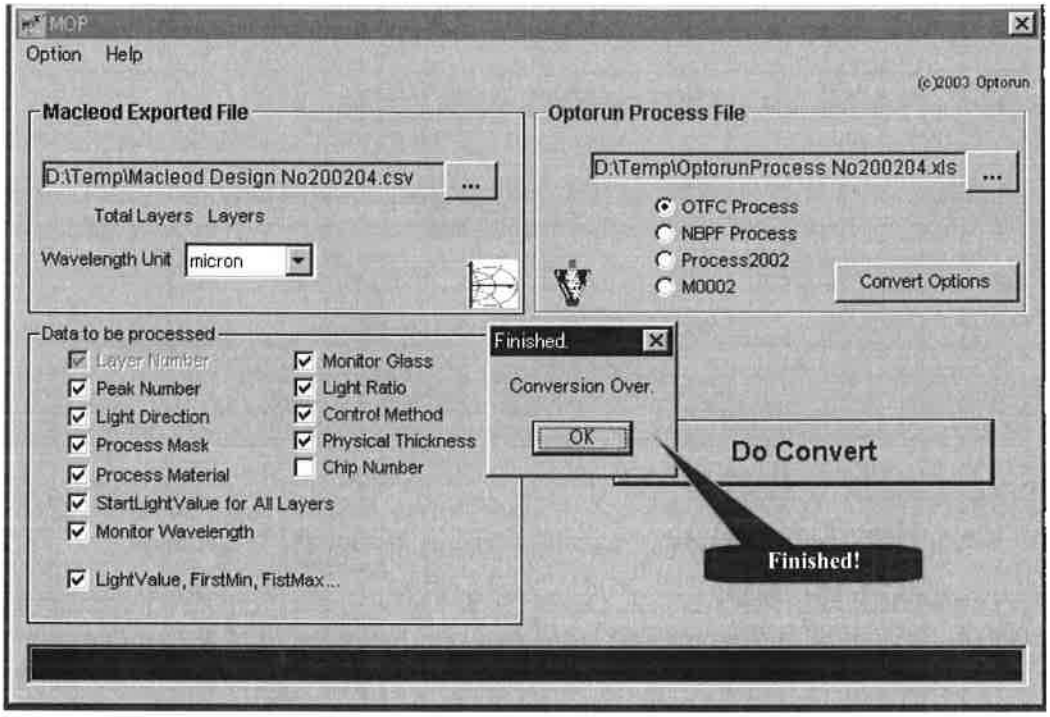

Fig. 9 Conversion finished.

5. Check conversion results

This step is important for getting reliable results, especially for reassuring that some approximations performed during the conversion are in accordance with user's intentions.

Note that as an accessory utility the *MOP* intends to reduce much of the cumbersome work of manual operation previously required by users. However minute difference might exist between converted results and user expectations, especially for those conversion data that are subject to approximation parameters (offered by user).

The following is one of the cases user should pay special attention to:

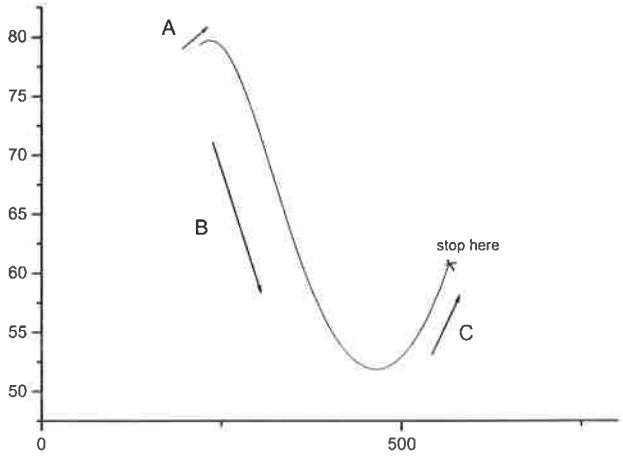

Fig. 10 Check conversion results - Select Appropriate Parameters

In **Fig. 10**, *MOP* utility program will possibly set the following parameters in Optorun *Process* file:

Peak Number = 2
Light Change Direction = Increase

However, pay attention to the area marked 'A', the increasing part of the monitoring signal is rather short, and it is well possible for the automatic control system to *overlook* such a peak. To avoid such misses, change the parameters in this way will get satisfactory results:

Peak Number = 1
Light Change Direction = Decrease

The same result can be achieved by using the approximation settings described in FinalSwing and StartSwing.

On the other side, checking converted results will reassure user of the approximations performed during conversion.

In order to realize reliable control, user is strongly recommended to scrutinize the converted Optorun *Process* file.