

SEMI P41-0304^E

SPECIFICATION FOR MASK DEFECT DATA HANDLING WITH XML, BETWEEN DEFECT INSPECTION TOOLS, REPAIR TOOLS, AND REVIEW TOOLS

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^E This standard was modified in September 2004 to correct editorial errors. Changes were made to Tables 2 and 3.

NOTICE: This Standard or Safety Guideline has an Inactive Status because the conditions to maintain Current Status have not been met. Inactive Standards or Safety Guidelines are available from SEMI and continue to be valid for use.

1 Purpose

1.1 This data structure specification uses the standard XML format for defect information communication between defect inspection tools, repair tools, and review tools at the mask production floor.

1.1.1 Mutual use of the defect information between the tools.

1.1.2 Optional usage by tools and systems other than defect inspection, repair, and review tools.

1.2 The equipment suppliers who utilize this standardized data structure can send and receive required information, with no dependence on specific software and specific hardware.

2 Scope

2.1 This standard can be applied to defect-related information on photomasks for semiconductor manufacturing.

2.2 This data structure defines the data hierarchy, the tag name, and contents of an XML file, which are transmitted. A particular database or a particular programming language is not specified in this standard.

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3 Limitations

3.1 This standard does not include the provision of defect information for wafer fabs.

3.2 This standard does not specify particular schema.

3.3 This standard does not address the name space issue.

4 Referenced Standards and Documents

4.1 *World Wide Web Consortium Document*¹

Extensible Markup Language (XML) 1.0 (Second Edition) — W3C, 6 October 2000 (<http://www.w3.org/TR/2000/REC-xml-20001006>)

4.2 *JEITA Document*²

Reticle Data Management Guideline Ver.1.0 (2001)

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

¹ World Wide Web Consortium (W3C), Website: <http://www.w3c.org>

² Japanese Electronic and Information Technology Industries Association, Tokyo Chamber of Commerce and Industry Bldg. 2-2, Marunouchi 3-chome, Chiyoda-ku, Tokyo 100-0005, Japan, <http://www.jeita.or.jp>

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 MDML — Mask Defect Markup Language

5.2 Definitions

5.2.1 *defect inspection information* — the information gathered with mask defect inspection tools, such as defect position and shape.

5.2.2 *mask defect markup language* — the name of the XML file defined in this standard.

6 Requirements

6.1 This standard defines the layered structure of an XML file, an element name, an attribute name and the contents described in them. Users of this standard have to define the style of the information described in an element and an attribute, and it must be published.

6.2 The information on defect inspection information, defect repair information, and defect review information is treated as one file. The MDML data item specifications defined in this standard are shown in Tables 2 through 7. The columns in these tables are described in the following sections. A layered structure is shown in Figures 2 through 7. Figure 1 is explanation of Figures 2 through 7.

6.2.1 *Item Name Column* — The name with which the data item is referenced.

6.2.2 *Element or Attribute Column* — Indicates whether the item is an element or an attribute.

6.2.3 *Mandatory or Optional Column* — Indicates whether the item is mandatory or optional.

6.2.4 *Data Type Column* — The type of data as defined in Table 1.

Table 1 Data Types

Type	Description
String	A string of ASCII characters from 0 to 32767 characters in length.
Integer	A string of numeric characters (0 through 9) that represent an integer value.
Float	A string representing a floating point value in exponent float.

6.2.5 *Description Column* — Description of what the data item is and what value restrictions it has.

Table 2 Description of Basic Information Section

Item	Element or attribute	Mandatory or Optional	Data Type	Description
MDML	Element	Mandatory	-	Root element.
data_no	Attribute	Optional	Integer	Management number in inspection tool.
date_stamp	Attribute	Optional	String	Generating time.
BasicInformation	Element	Mandatory	-	Top element of basic information.
MaskMaterialInformation	Element	Mandatory	-	Top element of material information.
MaskSize	Element	Mandatory	-	Mask size information.
unit	Attribute	Mandatory	String	Unit system.
shape	Attribute	Optional	String	Mask substrate shape.
MaskSize_X	Element	Mandatory	Float	Mask substrate size X.
MaskSize_Y	Element	Mandatory	Float	Mask substrate size Y.
MaskThickness	Element	Mandatory	Float	Mask substrate thickness.

<i>Item</i>	<i>Element or attribute</i>	<i>Mandatory or Optional</i>	<i>Data Type</i>	<i>Description</i>
MaskAbsorber	Element	Optional	String	Masking absorber.
DefectInspection	Element	Mandatory	-	Top element of basic information on defect inspection.
preparation_date	Attribute	Optional	String	Generating time of basic information on defect inspection.
InspectionTool	Element	Mandatory	-	Top element of defect inspection tool information.
tool_name	Attribute	Optional	String	General name of tool.
tool_no	Attribute	Optional	String	Tool management number at mask fab.
ToolCoordinateInformation	Element	Mandatory	-	Top element of tool work stage coordinate information. Subsequent structures are in Table 5. Refer to Figure 9.
InspectionMethod	Element	Mandatory	String	Defect inspection method.
PreparationOperator	Element	Optional	String	Operator name who created inspection basic information.
ReferenceAreaDB	Element	Optional	String	When reusable basic information exists, the reference address is to be described.
DirectionInformation	Element	Mandatory	-	Top element of direction for Mask and tool work stage. Subsequent structures are in Table 6. Refer to Figure 10.
AreaInformation	Element	Mandatory	-	Top element of inspection area information.
LensDistance	Element	Optional	Float	Lens separation at the die to die inspection.
unit	Attribute	Mandatory	String	Unit system.
InspectionArea	Element	Mandatory	-	Top element of inspection area. Refer to Figure 8.
unit	Attribute	Mandatory	String	Unit system.
InspectionArea_X	Element	Mandatory	Float	Inspection area X.
InspectionArea_Y	Element	Mandatory	Float	Inspection area Y.
InspectionAreaChip_X	Element	Mandatory	Float	Inspection area X of one die in die to die inspection.
InspectionAreaChip_Y	Element	Mandatory	Float	Inspection area Y of one die in die to die inspection.
ChipSize_X	Element	Mandatory	Float	Die size X in die to die inspection.
ChipSize_Y	Element	Mandatory	Float	Die size Y in die to die inspection.
InspectionChipNumber	Element	Mandatory	-	Element of die number.
InspectionChipNumber_X	Element	Mandatory	Integer	Inspected number of die in X at die to die inspection.
InspectionChipNumber_Y	Element	Mandatory	Integer	Inspected number of die in Y at die to die inspection.
Reference	Repeatable Element	Mandatory	-	Top element of reference point.
origin	Attribute	Mandatory	String	Origin point name of this reference position.
ReferencePointName	Element	Mandatory	String	Reference point name.
ReferencePosition	Element	Mandatory	-	Element of reference position.
unit	Attribute	Mandatory	String	Unit system.
ReferencePosition_X	Element	Mandatory	Float	X coordinate value of reference point.
ReferencePosition_Y	Element	Mandatory	Float	Y coordinate value of reference point.

<i>Item</i>	<i>Element or attribute</i>	<i>Mandatory or Optional</i>	<i>Data Type</i>	<i>Description</i>
ImageData	Repeatable Element	Mandatory	-	Image data of reference position. Subsequent structures are in Table 7.
InspectionStartPosition	Element	Mandatory	-	Top element of inspection starting position.
origin	Attribute	Mandatory	String	Origin point name of this reference position.
unit	Attribute	Mandatory	String	Unit system.
InspectionStartPosition_X	Element	Mandatory	Float	X coordinate value of inspection start position.
InspectionStartPosition_Y	Element	Mandatory	Float	Y coordinate value of inspection start position.

Table 3 Description of Result Summary Section

<i>Item</i>	<i>Element or Attribute</i>	<i>Mandatory or Optional</i>	<i>Data type</i>	<i>Description</i>
InspectionResult	Element	Mandatory	-	Top element of inspection results.
Summary	Element	Mandatory	-	Top element of summary information.
InspectionSummary	Element	Mandatory	-	Top element of defect inspection summary.
beginning_date	Attribute	Optional	String	Beginning time of defect inspection.
ending_date	Attribute	Optional	String	Ending time of defect inspection.
InspectionRecipe	Element	Mandatory	-	Element of inspection recipe.
recipe_name	Attribute	Optional	String	Inspection recipe name.
InspectionModeInformation	Element	Mandatory	String	Inspection mode.
InspectionDetectionSummary	Element	Mandatory	-	Top element of detected defect summary.
TotalDefect	Element	Mandatory	Integer	Number of detected defects in total.
ClassifyDefect	Repeatable Element	Mandatory	Integer	Number of defect types.
defect_type	Attribute	Mandatory	String	Defect type.
InspectionOperator	Element	Optional	String	Inspection Operator name.
ReticleJudgment	Element	Optional	String	Reticle disposition.
RepairSummary	Repeatable Element	Mandatory	-	Top element of repaired defect summary.
beginning_date	Attribute	Optional	String	Beginning time of defect repair.
ending_date	Attribute	Optional	String	Ending time of defect repair.
RepairTool	Element	Mandatory	-	Top element of repair tool information.
tool_name	Attribute	Optional	String	General name of tool.
tool_no	Attribute	Optional	String	Tool management number in mask fab.
ToolCoordinateInformation	Element	Mandatory	-	Top element of tool work stage coordinate information. Subsequent structures are in Table 5. Refer to Figure 9.
RepairMethod	Element	Mandatory	String	Method of defect repairing.
DirectionInformation	Element	Mandatory	-	Top element of direction for Mask and tool work stage. Subsequent structures are in Table 6. Refer to Figure 10.
NumberRepairProcessing	Element	Mandatory	-	Element of number of repair processed.
TotalRepairProcess	Element	Mandatory	Integer	Number of repaired defects in total.
CalssifyRepairProcess	Repeatable Element	Mandatory	Integer	Number of defect types.
defect_type	Attribute	Mandatory	String	Defect type.

<i>Item</i>	<i>Element or Attribute</i>	<i>Mandatory or Optional</i>	<i>Data type</i>	<i>Description</i>
RepairOperator	Element	Optional	String	Repair operator name.
RepairJudgment	Element	Optional	String	Judgegement of repair process.
EvaluationSummary	Repeatable Element	Mandatory	-	Top element of evaluated defect summary.
beginning_date	Attribute	Optional	String	Beginning time of evaluation.
ending_date	Attribute	Optional	String	Ending time of evaluation.
EvaluationTool	Element	Mandatory	-	Top element of evaluation tool information.
tool_name	Attribute	Optional	String	General name of tool.
tool_no	Attribute	Optional	String	Tool management number in mask fab.
ToolCoordinateInformation	Element	Mandatory	-	Top element of tool work stage coordinate information. Subsequent structures are in Table 5. Refer to Figure 9.
EvaluationMethod	Element	Mandatory	String	Method of defect evaluation.
DirectionInformation	Element	Mandatory	-	Top element of direction for Mask and tool work stage. Subsequent structures are in Table 6. Refer to Figure 10.
NumberEvaluationProcessing	Element	Mandatory	-	Element of number of evaluation process.
TotalEvaluationProcess	Element	Mandatory	Integer	Number of evaluated defects in total.
CalssifyEvaluationProcess	Repeatable Element	Mandatory	Integer	Number of defect types.
defect_type	Attribute	Mandatory	String	Defect type.
EvaluationOperator	Element	Optional	String	Evaluation operator name.
EvaluationJudgment	Element	Optional	String	Judgment of evaluation process.

Table 4 Description of Each Defect Section

<i>Item</i>	<i>Element or Attribute</i>	<i>Mandatory or Optional</i>	<i>Data Type</i>	<i>Description</i>
Defect	Repeatable Element	Mandatory	-	Top element of each defect information.
defect_type	Attribute	Mandatory	String	Defect type.
date_stamp	Attribute	Optional	String	Date classified.
DefectInformation	Element	Mandatory	-	Top element of defect information.
origin	Attribute	Mandatory	String	Origin point name of this reference position.
DefectPosition	Element	Mandatory	-	Element of defect position.
unit	Attribute	Mandatory	String	Unit system.
DefectPosition_X	Element	Mandatory	Float	X coordinate value of defect position.
DefectPosition_Y	Element	Mandatory	Float	Y coordinate value of defect position.
DefectSize	Element	Mandatory	-	Element of defect size.
unit	Attribute	Mandatory	String	Unit system.
DefectSize_X	Element	Mandatory	Float	X size value of defect.
DefectSize_Y	Element	Mandatory	Float	Y size value of defect.
DefectJudgment	Element	Mandatory	String	Judgment of defect.
ImageData	Repetable Element	Mandatory	-	Image data of defect. Subsequent structures are in Table 7.

<i>Item</i>	<i>Element or Attribute</i>	<i>Mandatory or Optional</i>	<i>Data Type</i>	<i>Description</i>
DefectRepair	Repetable Element	Mandatory	-	Top element of defect repair.
date_stamp	Attribute	Optional	String	Repair processing date.
RepairRecipe	Element	Mandatory	-	Element of repair recipe.
recipe_name	Attribute	Optional	String	Repair recipe name.
RepairCondition	Element	Mandatory	String	Repair conditions.
RepairResult	Element	Mandatory	String	Repair results.
ImageData	Repetable Element	Mandatory	-	Image data of repaired defect. Subsequent structures are in Table 7.
DefectEvaluate	Repetable Element	Mandatory	-	Top element of defect evaluation.
date_stamp	Attribute	Optional	String	Evaluation processing date.
EvaluateRecipe	Element	Mandatory	-	Element of evaluation recipe.
recipe_name	Attribute	Optional	String	Evaluation recipe name.
EvaluateCondition	Element	Mandatory	String	Evaluation condition.
EvaluateResult	Element	Mandatory	String	Evaluation result.
ImageData	Repetable Element	Mandatory	-	Image data of evaluated defect. Subsequent structures are in Table 7.

Table 5 Description of Tool Coordinate Section

<i>Item</i>	<i>Element or attribute</i>	<i>Mandatory or Optional</i>	<i>Data Type</i>	<i>Description</i>
CoordinateSystem	Element	Mandatory	String	Coordinate system of tool.
ToolOriginPointInformation	Element	Mandatory	-	Element of origin point information.
ToolOriginPoint	Element	Mandatory	String	Tool origin point information.
ToolOriginPosition	Element	Mandatory	-	Element of origin position.
unit	Attribute	Mandatory	String	Unit system.
ToolOriginPosition_X	Element	Mandatory	Float	X coordinate value of tool origin position.
ToolOriginPosition_Y	Element	Mandatory	Float	Y coordinate value of tool origin position.
ToolStageCorrectionInformation	Element	Mandatory	-	Top element of tool work stage correction information.
ToolStageCorrection	Element	Mandatory	-	Element of correction information.
unit	Attribute	Mandatory	String	Unit system.
ToolStageCorrection_X	Element	Mandatory	Float	Correction information of X coordinates.
ToolStageCorrection_Y	Element	Mandatory	Float	Correction information of Y coordinates.
ToolStageSkew	Element	Mandatory	-	Element of skew correction information.
unit	Attribute	Mandatory	String	Unit system.
ToolStageSkewCorrection	Element	Mandatory	Float	Skew correction information.
MaskOriginPointInformation	Element	Mandatory	-	Top element of mask origin position.
MaskOriginPoint	Element	Mandatory	String	Mask origin point information.
MaskOriginPosition	Element	Mandatory	-	Element of mask origin position.
unit	Attribute	Mandatory	String	Unit system.
MaskOriginPosition_X	Element	Mandatory	Float	X coordinate value of mask origin position.
MaskOriginPosition_Y	Element	Mandatory	Float	Y coordinate value of mask origin position.

Item	Element or attribute	Mandatory or Optional	Data Type	Description
ToolOffset	Element	Mandatory	-	Element of relative position information on tool origin and mask origin.
unit	Attribute	Mandatory	String	Unit system.
ToolOffset_X	Element	Mandatory	Float	X offset value of relative position of tool origin and mask origin.
ToolOffset_Y	Element	Mandatory	Float	Y offset value of relative position of tool origin and mask origin.
ToolStageAccuracy	Element	Optional	-	Tool work stage positioning accuracy information.
unit	Attribute	Optional	String	Unit system.

Table 6 Description of Mask Direction Information Section

Item	Element or attribute	Mandatory or Optional	Data Type	Description
ReferenceMark	Element	Mandatory	String	Information on the reference mark for expressing direction of mask.
MarkRotation	Element	Mandatory	String	Information of rotation direction on mask.
MaskMirror	Element	Mandatory	String	Information of mirror direction information on mask.
MaskFlip	Element	Mandatory	String	Information of flip direction information on mask.

Table 7 Description of Image Data Section

Item	Element or Attribute	Mandatory or Optional	Data Type	Description
ImageReferenceAddress	Element	Optional	String	Reference address information of image data.
ImageInformation	Element	Mandatory	-	Element of image data information.
ImageFormat	Element	Mandatory	String	Image data format information.
ImageMagnification	Element	Mandatory	Float	Image data magnification information.
ImagePixelNumber_X	Element	Mandatory	Integer	Number of pixels in X.
ImagePixelNumber_Y	Element	Mandatory	Integer	Number of pixels in Y.
ImagePixelSize	Element	Mandatory	-	Element of pixel size on image data.
unit	Attribute	Mandatory	String	Unit system.
ImagePixelSize_X	Element	Mandatory	Float	Size of one pixel in X.
ImagePixelSize_Y	Element	Mandatory	Float	Size of one pixel in Y.
ImageGrayLevel	Element	Mandatory	String	Gray level information of image data.
ImageIllumination	Element	Mandatory	String	Illumination information of image data.
ImageRotation	Element	Mandatory	String	Rotation information of image data.
ImageMirror	Element	Mandatory	String	Mirroring information of image data.
ImageFlip	Element	Mandatory	String	Flipping information of image data.
ImageConvertInformation	Element	Optional	-	Element of image conversion information from original/raw data.
ImageContrast	Element	Mandatory	String	Image contrast information.
ImageBrightness	Element	Mandatory	String	Image brightness information.
ImageConversionParameter	Element	Mandatory	String	Image conversion parameter information.

<i>Item</i>	<i>Element or Attribute</i>	<i>Mandatory or Optional</i>	<i>Data Type</i>	<i>Description</i>
ImageReference	Element	Mandatory	-	Top element of image origin point. Refer to Figure 11.
origin	Attribute	Mandatory	String	Origin point name of this reference position.
ImageReferencePoint	Element	Mandatory	String	Image reference point information.
ImageReferencePosition	Element	Mandatory	-	Element of image reference position coordinate value.
unit	Attribute	Mandatory	String	Unit system.
ImageReferencePosition_X	Element	Mandatory	Float	X coordinates value of image reference position.
ImageReferencePosition_Y	Element	Mandatory	Float	Y coordinates value of image reference position.
ImageTarget	Element	Mandatory	-	Element of image target.
origin	Attribute	Mandatory	String	Origin point name of this reference position.
ImageTargetPosition	Element	Mandatory	-	Element of target position on image data. Refer to Figure 12.
unit	Attribute	Mandatory	String	Unit system.
ImageTargetPosition_X	Element	Mandatory	Float	X coordinate value of image target position.
ImageTargetPosition_Y	Element	Mandatory	Float	Y coordinate value of image target position.
ExpressionMark	Element	Mandatory	String	Expression of target point on image data.

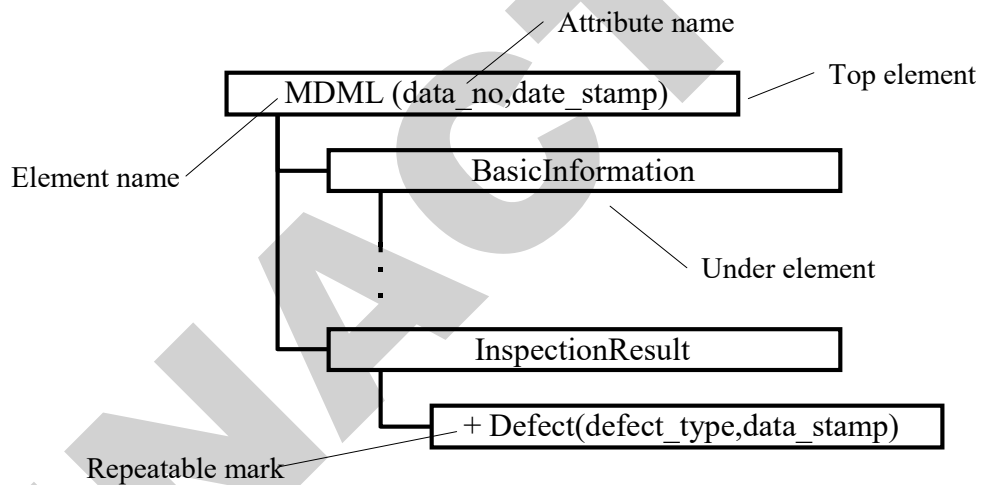


Figure 1
Explanation of Figures 2 Through 7

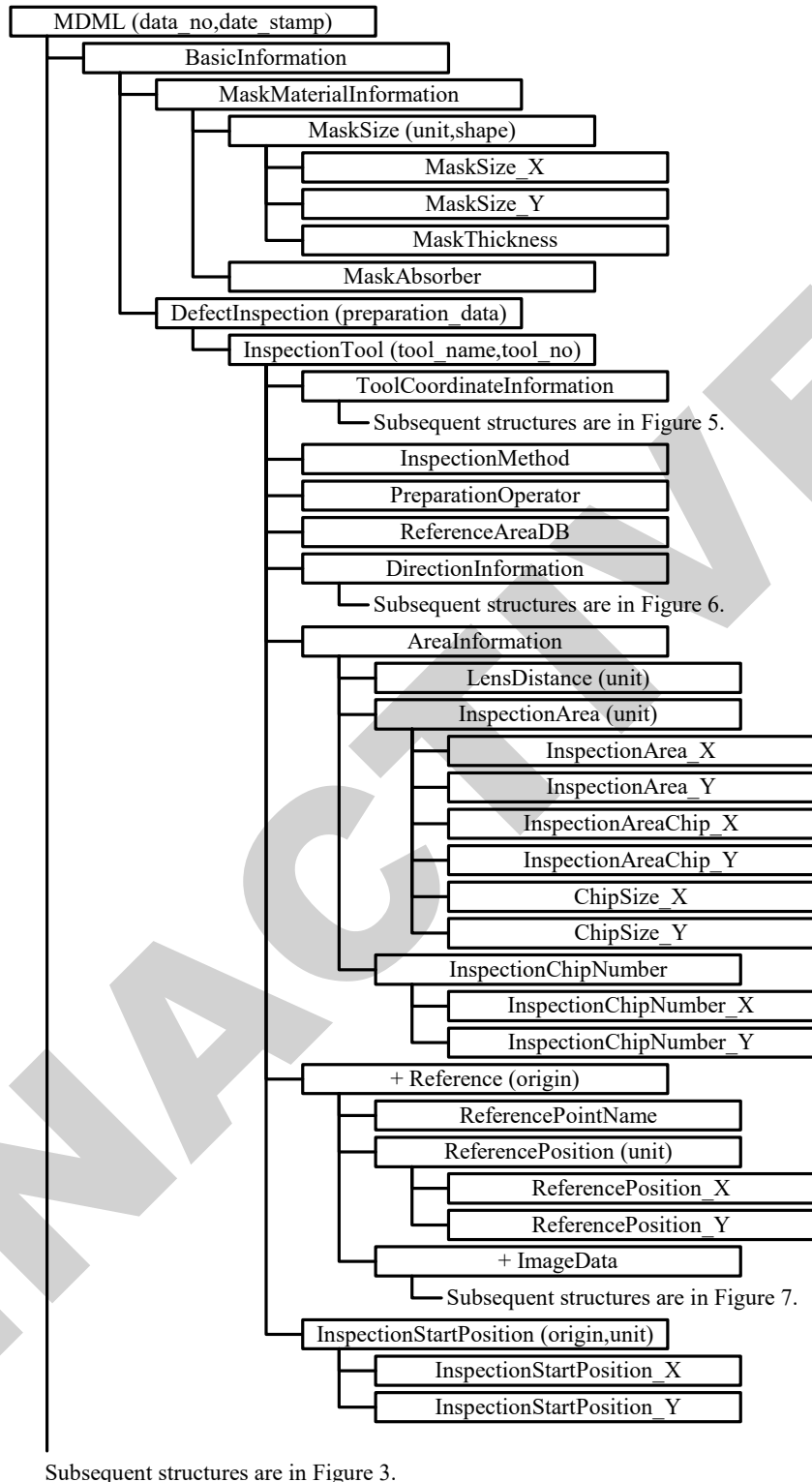


Figure 2
Structure of Basic Information Section