Background Statement for SEMI Draft Document 5907
Revision to SEMI P5-0704, SPECIFICATION FOR PELLICLES

Notice: This background statement is not part of the balloted item. It is provided solely to assist the recipient in reaching an informed decision based on the rationale of the activity that preceded the creation of this Document.

Notice: Recipients of this Document are invited to submit, with their comments, notification of any relevant patented technology or copyrighted items of which they are aware and to provide supporting documentation. In this context, "patented technology" is defined as technology for which a patent has issued or has been applied for. In the latter case, only publicly available information on the contents of the patent application is to be provided.

Background Statement:

Since SEMI P5 was published, progress has been made in developing Pellicles for EUV reticles which needs to be incorporated into P5.

Proposals consider that EUV pellicles are new to the industry and as such there are materials and material innovations which can be considered product differentiators. This precludes having some of the minimal requirements like the non-EUV pellicles have in the specification. Therefore these items are not specified.

Note: Additions to the current standard are indicated by underline and deletions are indicated by ~~strikethrough.~~

The ballot results will be reviewed and adjudicated at the meetings indicated in the table below. Check www.semi.org/standards under Calendar of Events for the latest update.

Review and Adjudication Information

	Task Force Review	**Committee Adjudication**
Group:	Extreme Ultraviolet (EUV) Mask TF	NA TC Chapter of Microlithography
Date:	TBD (SPIE 21 - 25 February 2016)	Wed, Feb 24, 2016
Time & Timezone:		6:00 PM – 8:00 PM PDT
Location:	San Jose Convention Center	San Jose Convention Center
City, State/Country:	San Jose, California / USA	San Jose, California / USA
Leader(s):	John Zimmerman, Emily Gallagher, Markus Bender	Wes Erick, Bryan Barnes
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This meeting's details are subject to change, and additional review sessions may be scheduled if necessary. Contact the task force leaders or Standards staff for confirmation.

Telephone and web information will be distributed to interested parties as the meeting date approaches. If you will not be able to attend these meetings in person but would like to participate by telephone/web, please contact Standards staff.

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SEMI Draft Document 5907

Revision to SEMI P5-0704, SPECIFICATION FOR PELLICLES

Note: Additions to the current standard are indicated by underline and deletions are indicated by ~~strikethrough.~~

NOTICE: This document was completely rewritten in 2004 to combine SEMI P5, SEMI P5.1, and SEMI P5.2.

1 ~~Preface~~Purpose

1.1 This specification covers the general requirements for pellicles used on photomasks or reticles in photolithographic exposure systems. ~~This specification covers requirements for pellicles used on photomasks or reticles in photolithographic exposure systems. This specification covers pellicles for use in either broadband, polychromatic or monochromatic exposure systems~~

~~**NOTICE:** This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.~~

2 Scope

2.1 This document covers pellicles for use in either broadband, polychromatic or monochromatic exposure systems.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

~~2~~ 3 Referenced Standards and Documents

~~2.1~~ 3.1 None.

~~3~~ 4 Terminology

~~3.1~~ 4.1 Additional terms are listed for information only in the glossary, SEMI Compilation of Terms.

~~3.2~~ 4.2 *Selected Definitions*

~~3.2.1~~ 4.2.1 *pellicle* — a thin, optically transparent film, typically of a polymer, attached to and supported by a frame, and attached to a photomask (or reticle). Its purpose is to seal out contaminants and reduce printed defects caused by contamination in the image plane of an optical exposure system with a minimum decrease in the quality of optical transmission.

~~3.2.2~~ 4.2.2 *film adhesive* — adhesive between frame and film.

~~3.2.3~~ 4.2.3 *frame adhesive* — adhesive between frame and photomask.

~~3.2.4~~ 4.2.4 *mechanical strength* — the physical condition a pellicle must meet to withstand a specified force from a blow-off gun without suffering any damage to the film due to stretching or breakage.

~~3.2.5~~ 4.2.5 *film defects* — inconsistencies in the integrity and planarity of the film, including particles, pinholes, scratches, dirt, and a minute quantity of solid.

~~3.2.5.1~~ 4.2.5.1 *particle* — materials that can be distinguished from the film whether on the film surface or embedded in the film.

~~3.2.5.2~~ 4.2.5.2 *dirt* — fingerprint; mark left behind after operator handling; stain from liquid.

~~3.2.5.3~~ 4.2.5.3 *pinhole* — a small opening completely through a polymer film.

~~3.2.5.4~~ 4.2.5.4 *scratch* — long, narrow, shallow groove or cut below the established plane of the surface.

~~3.2.6~~ 4.2.6 *adhesive stringer* — any detectable protrusion from the edge of the adhesive.

~~3.2.7~~ 4.2.7 *light resistance* — minimum cumulative exposure energy a pellicle can withstand without (or within specified) change in performance.

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~~4~~ 5 Ordering Information

~~4.1~~ 5.1 Purchase orders of pellicles furnished to this specification shall include the following:

~~4.1.1~~ 5.1.1 *Shape, Size, and Standoff of Pellicle* — The information relating to the Shape, Size, and Standoff of a pellicle may be combined into a single frame part number, or must be provided separately. For any given model of stepper or mask aligner the manufacturer will specify a recommended shape, size and standoff. The user for inter-operability reasons may specify alternative values.

~~4.1.1.1~~ 5.1.1.1 *Shape* — This is determined by agreement between the user and the supplier.

~~4.1.1.2~~ 5.1.1.2 *Size* — This is determined by agreement between the user and the supplier. Any expression of tolerance is as follows:

- Outer edge tolerance: +0, −x
- Inner edge tolerance: +x, −0

~~4.1.1.3~~ 5.1.1.3 *Standoff* — This is determined by agreement between the user and the supplier. Any expression of tolerance is +0, −x.

~~4.1.2~~ 5.1.2 *Film Characteristics*

~~4.1.2.1~~ 5.1.2.1 *Type* — An anti-reflective (AR) coating may be applied to either the inside or outside surfaces of the polymer film. Which surfaces, if any, require the presence of an AR-coating is determined by agreement between the user and the supplier.

~~4.1.2.2~~ 5.1.2.2 *Exposure Range or Wavelength* — The wavelength(s) of the exposure system(s) must be specified. Table 1 shows the typical exposure wavelengths.

Table 1 Typical Exposure Wavelengths

Terminology	*Exposure Wavelength(s)*
Broadband	360–440 nm
g-line	436 nm
h-line	405 nm
i-line	365 nm
DUV	248 nm
DUV 193	193 nm
EUV	13.5 nm

~~4.1.2.3~~ 5.1.2.3 *Optical Transmission*

5.1.2.3.1 For non-EUV wavelengths, there are two types of optical transmission depending on the film type. These are measured at an incident angle of 90° from the surface of the pellicle at the specified wavelength(s). The acceptable values are specified in Tables 2 and 3. The Minimum Transmission given in Table 3 apply to all wavelengths the film is specified for.

~~4.1.2.3.1~~ 5.1.2.3.2 For EUV wavelengths, the transmission and transmission uniformity is determined by agreement between the user and the supplier.

Table 2 Transmission for Broadband Exposure Systems

Type	*Average*	*Minimum*
AR-Coated	≥98%	96%
Non-AR-Coated	≥91%	82%

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Table 3 Transmission for Monochromatic Exposure Systems

Type	*Minimum*
AR Coated	99%
Non AR Coated	98%

~~4.1.2.4~~ 5.1.2.4 *Thickness* — This is determined by agreement between user and supplier. For non-EUV wavelengths, the default thickness tolerance is ±0.1 µm maximum for Broadband Exposure Systems and ±0.05 µm maximum in all other cases. For EUV wavelengths there is no default thickness tolerance.

~~4.1.2.5~~ 5.1.2.5 *Mechanical Strength*

~~4.1.2.5.1~~ 5.1.2.5.1 For non-EUV pellicles, the pellicle film must withstand air blow within ranges shown below:

- Air pressure: ≤2.1 kgf/cm^2 (at input of the air blow gun).
- Nozzle diameter of the air blow gun: ≤2 mm.
- Distance between the nozzle tip and the film: ≥25 mm.
- For EUV pellicles, the mechanical strength is specified by agreement between the user and the supplier.

~~4.1.2.6~~ 5.1.2.6 *Defect Limits* — Maximum defect limits are determined by agreement between the user and the supplier. These are based on the pellicle standoff, the numerical aperture and exposure wavelength of the given type of exposure system, and a typical specification is given in Table 4. For broadband exposure systems a typical value of size would be 45 µm, and for monochromatic exposure systems the size will be significantly smaller.

Table 4 Maximum Defect Limits

Characteristics	*Max. No. Allowable*	*Size Counted for Max. No. Allowable*
Non-removable		
Particles	None	>***size*** µm
Pinholes	None	>limit of detection
Scratches	None	Width >***size*** µm
Dirt	None	>limit of detection

~~4.2~~ 5.2 In addition, the following items may also be specified:

~~4.2.1~~ 5.2.1 Frame Material or Type.

~~4.2.2~~ 5.2.2 Frame Finishing or Coating.

~~4.2.3~~ 5.2.3 Frame Shape, Size and Height.

~~4.2.4~~ 5.2.4 Frame Adhesive Material or Type.

~~4.2.5~~ 5.2.5 Frame Adhesive Thickness and Width.

~~4.2.6~~ 5.2.6 Film Adhesive Material or Type.

~~4.2.7~~ 5.2.7 Film Adhesive Thickness and Width.

~~4.2.8~~ 5.2.8 Film Thickness Uniformity.

~~4.2.9~~ 5.2.9 Pellicle Vent Mechanism, e.g., vent hole.

~~4.2.10~~ 5.2.10 Frame inner-wall adhesive.

~~4.3~~ 5.3 If two pellicles will be attached to a photomask then each pellicle should be independently specified. For thicker photomask substrates a pellicle is only attached to the patterned side of the photomask. For thinner photomask substrates a pellicle is normally attached to both the patterned and glass sides of the photomask.

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~~5~~ 6 Requirements

~~5.1~~ 6.1 *Film Adhesive*

6.1.1 For non-EUV pellicles, film must be sealed on the entire top of the frame. Seal with a minimum of 50% of the frame width at any location.

~~5.1.1~~ 6.1.2 For EUV pellicles, film adhesive requirements are determined by agreement between the user and the supplier.

~~5.2~~ 6.2 *Frame Adhesive*

6.2.1 For all pellicles, no part of the frame or mounting adhesive may extend beyond the frame wall, and its edges must be free of visually detectable stringers (and particles).

~~5.2.1~~ 6.2.2 For non-EUV pellicles, frame adhesive must be continuous and allow no gaps larger than the Defect Size Limit between pellicle frame and adhesive, and between adhesive and photomask after attachment. Adhesive should form a complete seal between the frame and the mask over a minimum of 60% of the width of the frame.

~~5.2.2~~ 6.2.3 For EUV pellicles, frame and/or mounting adhesive requirements are determined by agreement between the user and the supplier.

~~5.3~~ 6.3 *Frame* — Pellicle frame must have no visually detectable machining burrs, discontinuities in anodization, or particles.

~~5.4~~ 6.4 *Light Resistance*

~~5.4.1~~ 6.4.1 For Broadband Exposure Systems this is expressed by total exposure energy value (mj/cm^2 or j/cm^2) on pellicle film until dropping 1% of optical transmission of one of the peak wavelengths between 360–440 nm. The test conditions (special characteristics of exposure wavelength, exposure energy between 360–440 nm, exposure conditions, and others) must be stated. Under these conditions, the pellicle shall release no material, which could contaminate the photomask or the pellicle itself.

6.4.2 For Monochromatic Exposure Systems this is expressed by total exposure energy value (mj/cm^2 or j/cm^2) of specified wavelength on pellicle's film until dropping 0.5% of optical transmission at specified wavelength. Also, the test conditions (half bandwidth of exposure specified wavelength, energy of exposure specified wavelength, exposure conditions, and others) must be stated. Under these conditions, the pellicle shall release no material, which could contaminate the photomask or the pellicle itself.

~~5.4.2~~ 6.4.3 For EUV exposure systems, light resistance is determined by agreement between the user and the supplier.

~~5.5~~ 6.5 *Other Characteristics* — Other characteristics of pellicles are to be determined between the supplier and the user. The transmission of light for mask alignment is such a characteristic.

~~6~~ 7 Measurement Methods

~~6.1~~ 7.1 Measurement methods are to be determined between the user and supplier. General and example methods are as follows:

- Optical Transmission: by spectrophotometer
- Optical Film Thickness: by spectrophotometer
- Thickness Uniformity: by monochromatic (e.g., green) light
- Width of Film Adhesive: Visual check by minimum defect sample
- Defects: Visual check by maximum sample or particle detector

~~7~~ 8 Sampling

~~7.1~~ 8.1 Inspection levels shall be agreed upon between the user and supplier.

~~8~~ 9 Handling

~~8.1~~ 9.1 Pellicles are to be handled by the frame only.

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~~9~~ 10 Certification

~~9.1~~ 10.1 Certification is to be determined between the user and supplier.

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