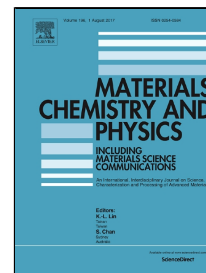


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Induction of tin pest for cleaning tin-drop contaminated optics

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# Induction of tin pest for cleaning tin-drop contaminated optics

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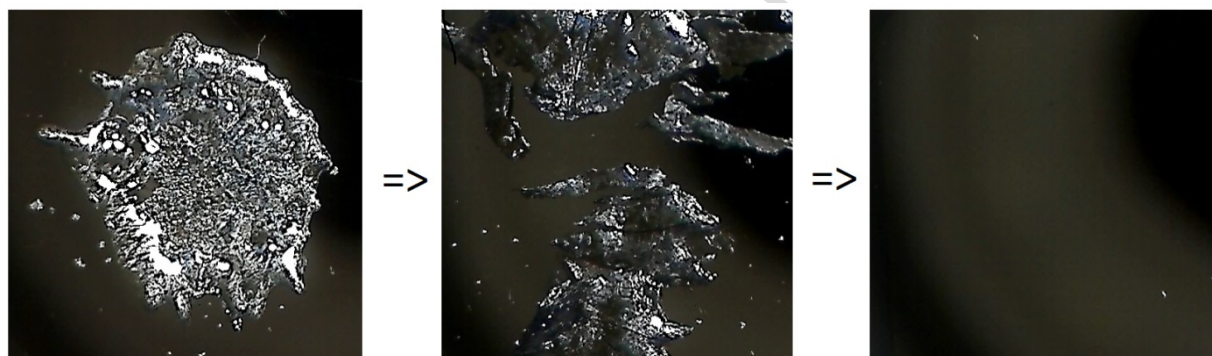
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## Highlights

- Tin pest induction leads to embrittlement of tin drops after  $\beta \rightarrow \alpha$  Sn transformation.
- The purity grade influences the transformation speed of tin very strongly.
- Tin drops on multilayer-coated optics disintegrate after  $\beta \rightarrow \alpha$  Sn transformation.
- Tin drop contamination of optics is cleaned via phase transformation at  $-24$  °C.
- Reflectance of multilayer-coated mirrors is restored after tin drop transformation.

## Graphical Abstract



## Abstract

Tin pest, the allotropic  $\beta \rightarrow \alpha$  phase transformation of tin, was examined for use in cleaning of tin-contaminated optics. Induction of change in material structure led to disintegration of tin samples into pieces and powder. The transition times were studied for tin drops of different purity grades, using inoculation with  $\alpha$ -Sn seed particles, also after prior mechanical deformation and surface oxide removal. For tin of very high purity levels fast nucleation within hours and full transformation within a day could be achieved during cooling at  $-24$  °C, resulting in strong embrittlement of the material. Tin dripped onto samples of multilayer-coated optics as used in extreme ultraviolet lithography machines was made cleanable by phase transition after inoculation and cooling. The reflectance of multilayer-coated mirrors was found to decrease by no more than 1% with this cleaning method.

## Keywords:

Phase transitions, Structural changes, Multilayer coating, Optics cleaning, Extreme ultraviolet lithography

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