



Fabrication of Target for LPP EUVL at Osaka University

**Qincui Gu, Keiji Nagai, Takayoshi Norimatsu, Hiroaki Nishimura,
Katsunobu Nishihara, Noriaki Miyanaga, Yasukazu Izawa**

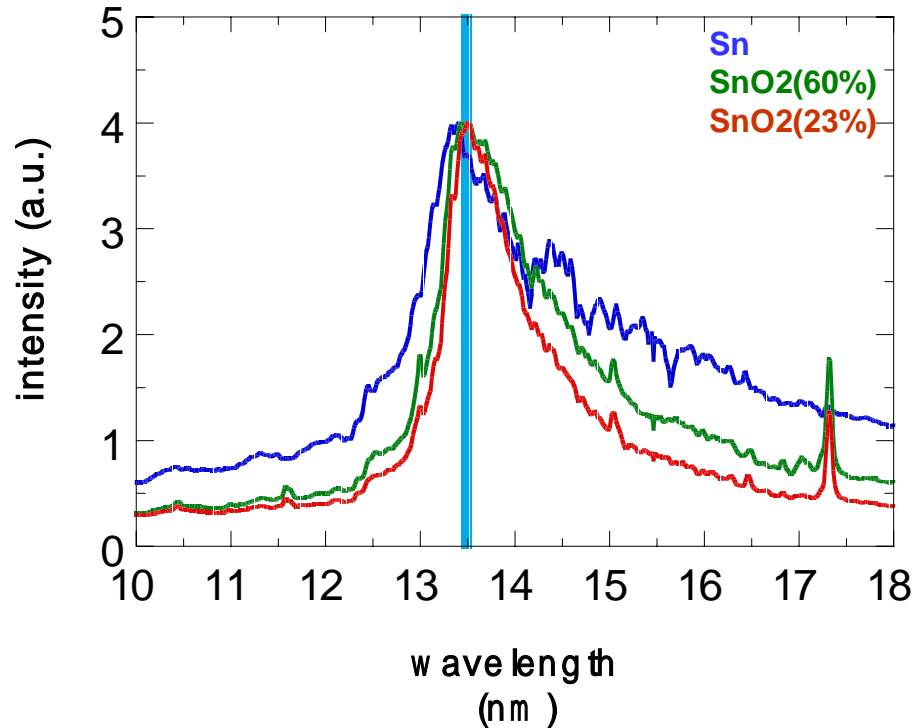
**Institute of Laser Engineering, Osaka University,
2-6 Yamada-oka, Suita, Osaka**



Introduction



Important Material for LPP EUVL—Xenon (Xe) and Tin (Sn)



Effect of low-density on EUV emission

- 1). Narrowing spectrum
- 2). High conversion efficiency
- 3). Low mass and corresponding debris mitigation



Nagai, K., et al. *Trans. Mater. Res. Soc. Jpn*, 2004, 29 : 943



Methods for preparing low-density SnO₂



1. **Polystyrene(PS) Template Method** → **One shot target**
2. **Polymer composite method** → **Repetition target**



Polystyrene(PS) template method

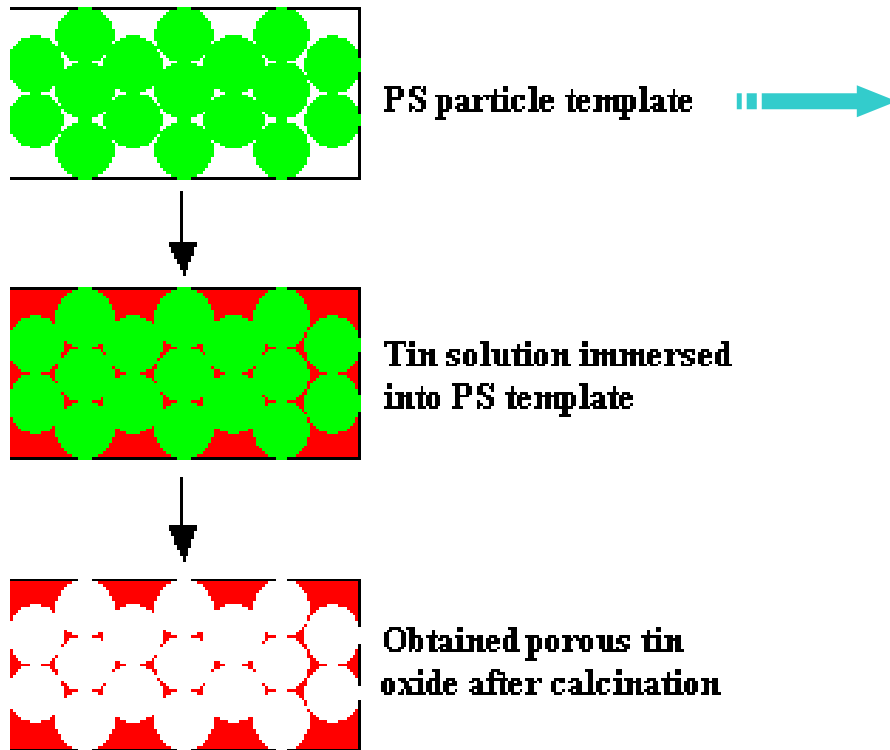


Photo of PS particle film

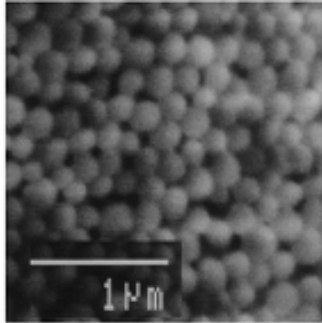
Scheme of preparing SnO_2 with PS template method



Porous SnO₂ prepared from tin chlorides (SnCl₄)

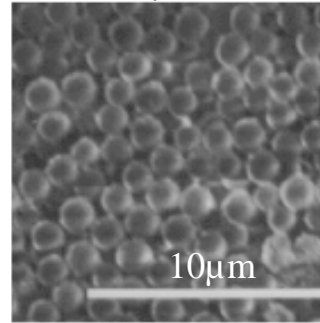


200nm



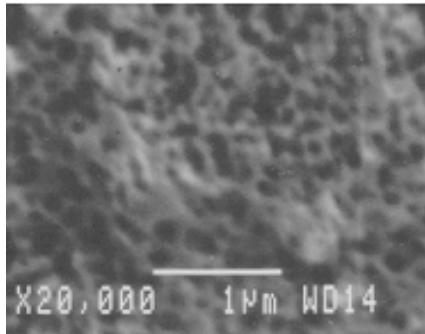
PS particles

1µm

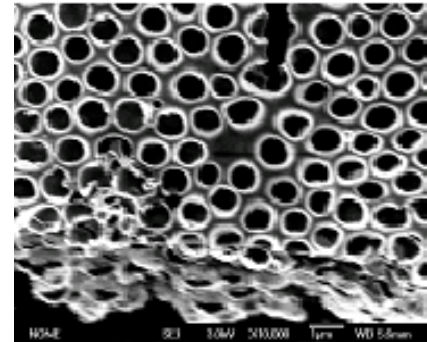


**Pore size: equivalent to
PS particle size**

**Density: 1.6g/cm³ (23 %
of bulk SnO₂)**



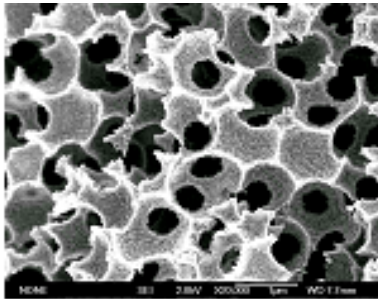
Porous SnO₂



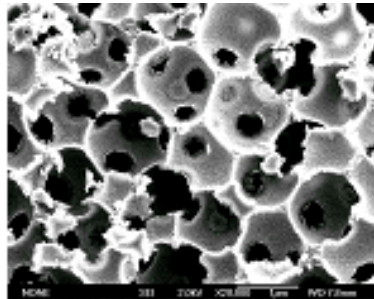
SEM images of PS template and corresponding porous SnO₂



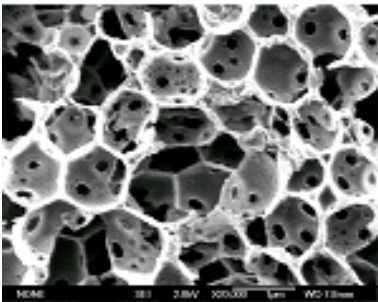
Porous SnO₂ prepared from SnCl₄/Ethanol/H₂O solution



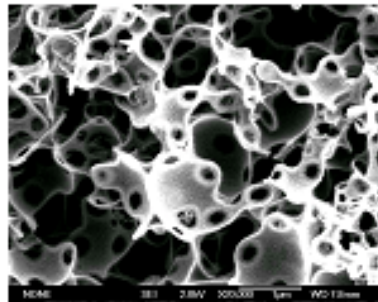
2



4



6



10

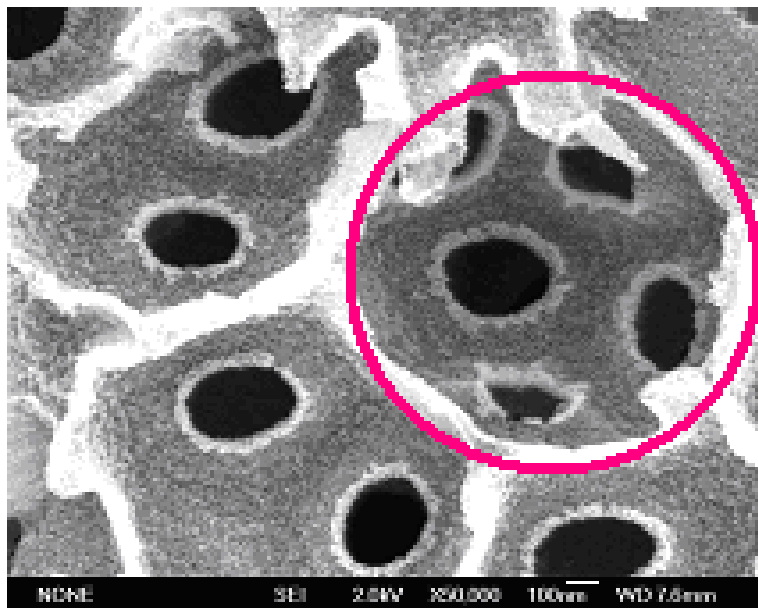
**Pore size: hierachical pore
from 10~1000nm**

**Density: 0.5g/cm³ (7%
of bulk SnO₂)**

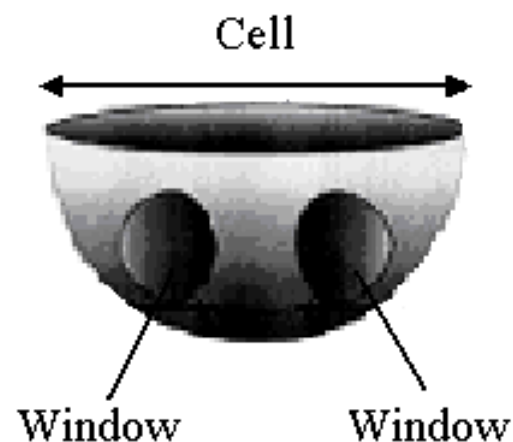
SEM images of porous SnO₂ prepared from SnCl₄/Ethanol/H₂O solution with different molar ratio of SnCl₄/Ethanol (as the data under the figures shows)



The strut-like structure of 7% SnO₂



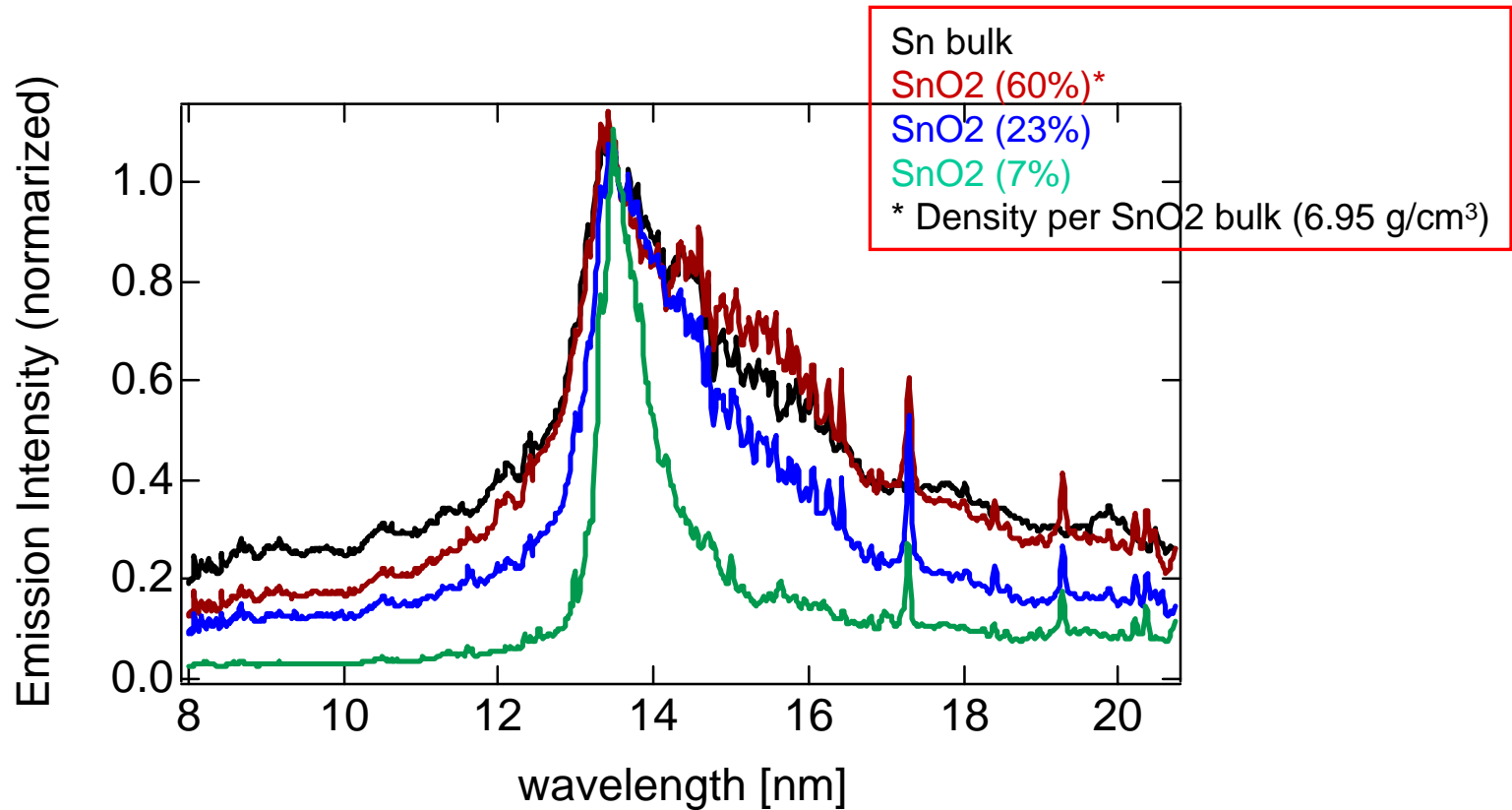
Strut-like structure



Magnified scheme of a cell



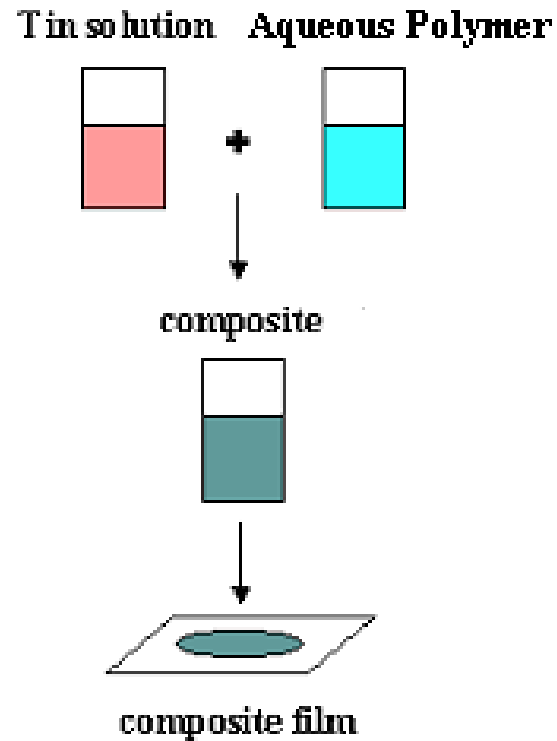
EUV emission of low-density SnO₂



In contrast to other tin-content material, 7% SnO₂ produces a much narrower and sharper emission peaks at 13.5nm, and the emission intensity remains unchanged



Polymer Template Method



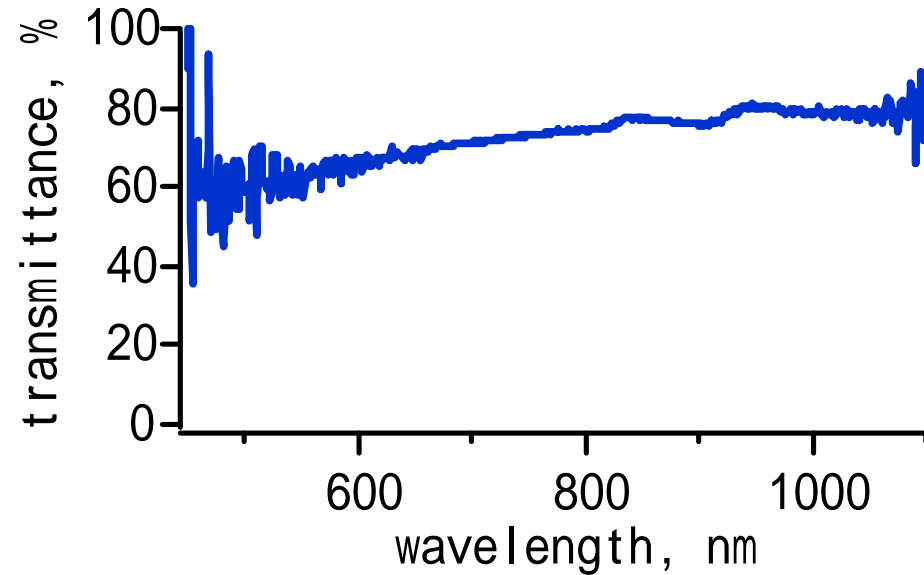
Scheme of preparing Polymer/Sn composite film



Transparent and Flexible Composite Film



Transparent and flexible Film



The spectral transmittance of film

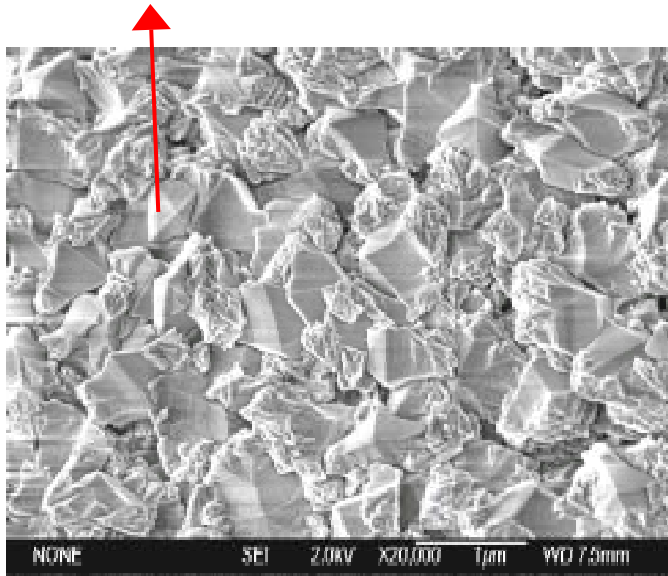
The transparent and flexible film simplifies the repetition target fabrication process, just coat the film on rotating aluminum column by thermal treatment.



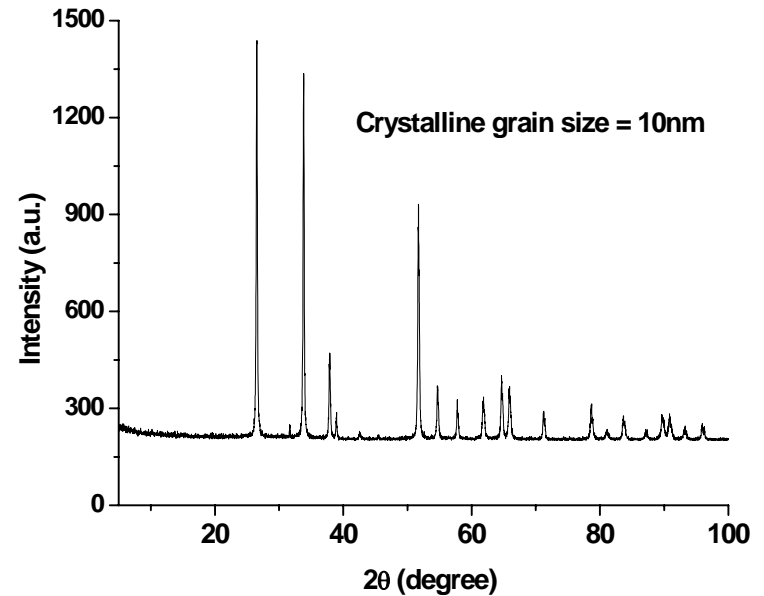
The As-prepared SnO₂ from Composite Film



Tetrahedral crystal



SEM image of as-prepared SnO₂



WAXD pattern of as-prepared SnO₂

Density: 1.9g/cm³ (28% of bulk SnO₂) ; Nanocrystalline Grain size: 10 nm



Summary



- **Two kinds of low-density SnO₂, 23% and 10%, was prepared by the combined techniques of PS template and tin source solution.**
- **By casting a mixture of tin solution and aqueous polymer a transparent and flexible composite film of polymer/Sn was obtained, as simplify the target fabrication and benefit the rotation target fabrication.**
- **Nanocrystalline SnO₂ (10nm grains) with tetrahedral crystalline structure was obtained from organic/inorganic hybrid composite polymer/Sn.**



Acknowledgement



A part of this work was auspiced by MEXT (Ministry of Education, Culture, Science and Technology, Japan) under contract subject “Leading Project for EUV lithography source development”.