EUV Source Modeling Workshop

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Workshop Summary

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Workshop Summary
Session 1: Atomic data for EUV

- **Much progress has been made since last workshop, but still needs more study for 4d-4f transition. Now following atomic data are available:**
  - **Xe (Tanuma) : (identified charge state)**
    - **Xe photon emission spectroscopy / charge exchange (Xe).**
    - **13.5 nm Xe^{+10}, also Xe^{+9} and Xe^{+11} although they are relatively small.**
    - **(Sn is also possible)**
  - **Sn (Koshelev/Bakshi)**
    - **Sn spark plasma**
    - **Line identification in progress**
  - **Opacity measurement of Sn (Fujioka)**
    - **Importance of width of transition arrays for EUVL use (Sasaki)**

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Workshop Summary
Session 2: LPP and GDPP CE

(II) LPP and GDPP conversion efficiency:

a few % CE from Sn and Li (and more up to 6%)

A) What is the ultimate limit for CE for Xe and Sn based EUV Sources (GDPP/LPP)?

Sn: self-absorption of EUV, Xe: less self-absorption (Sunahara)
for Sn, advantage for long laser wavelength (such as CO2)
for Xe, relatively weak dependence of laser wavelength
Sn : 4% (opacity effect), Xe : 1% (Sunahara)
Sn : 4 – 6% (low density, large volume) (O'Sullivan)
Sn : number atoms 10e12 Sn (2-3%) with tin droplet target (Richardson)
5.5 % Sn planer target -→ 4% with spherical target and high repetition
optimum laser pulse duration depends various target parameters
Sn : opacity effect-→ optimum pulse duration (<10ns) (Fujioka)

CE (Xe) GDPP; 0.8% (depends on precise parameters) (Hassanein)
small EUV source size Sn < Xe , collectable EUV Sn > Xe (- 2 times) in GDPP
discuss optimum density and temperature based on spectral efficiency in 13-14nm for both Sn, Xe (Zakharov)

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Workshop Summary

Session 2: LPP and GDPP CE

(II) LPP and GDPP conversion efficiency (Continued)

Li CE (Retting)

- **66% kinetic energy loss, 15% radiation loss**
- **large emission of EUV comes after laser turn-off**
- **Stark broadening**
- **CE 2 – 3 % at 5x10e10 – a few 10e11 W/cm2**
- **less dependence of laser wavelength**
- **CE increases with pulse length up to a few tens ns.**

Li target design (Alman)

- **Number of Li atoms = 1.2x10e15 for photons of 2.7x10e15 for 400 W in band**

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Workshop Summary
Session 3: Fast Ion and Debris

(III) Fast ion and debris :

- **Precise study has started and need more work**
- **Model predicts fast ion energy up to 100 keV due to isothermal expansion (Kang)**
- **Li coating on Ru + He plasma for long lifetime mirror (Alman)**
- **Need more data to verify to models**

Workshop Summary
Session 4: What issues should be addressed?

(IV) what issues should be addressed?

- **Exchange of large amount of atomic data (how?) should be addressed (Sasaki)**
- **Evaluation of atomic data is necessary, benchmarking also (Sasaki)**
- **DPP: electrode lifetime modeling: atomic physics, computer power (ANL)**
- **Debris mitigation , fast diagnostics (Rice)**
- **Modeling tool for designing (Retting)**
- **Exchange knowledge between exp. and theory. (Borisov)**

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