Oxygen discharges diluted with argon: Dissociation processes
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Introduction
• Addition of Ar to the O₂ discharge, while asking photostim. in-
  creases the plasma density and etch rate approximately by a factor
  of 2 (Takechi and Lieberman, 2003).

The global (volume averaged) model
• We use a global (volume averaged) model to study the dissocia-
  tion processes and the presence of negative ions and metastable
  species in a low pressure high density O₂/Ar discharge.
• In addition to electrons the oxygen discharge consists of molecu-
  lar oxygen in ground state O₂(3Σg⁻), metastable molecular oxygen
  O₂(3Δg), O₂(3Σg⁻) and O₂(A³Σg⁺), atomic oxygen in ground state
  O(3P), metastable atomic oxygen O(3D), ozone O₃, the positive ions
  O⁺, O₂⁺ and the negative ions O⁻, O₂⁻ and O₃⁻.
• We use a significantly revised reaction set for the oxygen dis-
  charge (Gudmundsson, 2004).
• The electron temperature versus pressure. The applied
  power is 500 W, the gas flow rate 50 sccm.

Results and discussion
• The chamber is assumed to be made of stainless steel, cylindric
  al with R = 10 cm and L = 10 cm.
• The applied power is 500 W, the gas flow rate 50 sccm.
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• The electron temperature versus pressure. The applied
  power is 500 W, the gas flow rate 50 sccm and the argon content 25 ,
  50 and 75 %.

Comparison to experiments
• The majority of the ground state atomic oxygen O(3P) originates
  from the metastable atom O(3D).
• About 21 – 40 %, depending on the argon content, is created by
  electron impact destillation of the metastable atom O(3D).

Electron impact dissociation of the O₂ molecule accounts for roughly
25 – 30 % of the O(3P) creation.
The destruction of O(3P) is mainly through wall recombination and
electron impact excitation.
The metastable oxygen atom is created mainly through electron im-
pact excitation of the oxygen atom, roughly 75 – 85 % contribution,
decreasing with increased argon content.

Conclusions
• The electron temperature increases with increased argon content due
to the higher ionization potential of argon compared to atomic
  and molecular oxygen.
• The fractional dissociation increases with increased argon content
due to increased electron impact dissociation with higher electron tem-
  perature.

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pressure oxygen processing discharge. Technical Report RH-17-2004,
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Figure 1: The recombination coefficient of oxygen atoms at the
  chamber walls for stainless steel as a function of pressure. The mea-
  sured data is taken from Singh et al. (2006) and Matsushita et al.
a Stokke et al. (2002). The recombinations at the walls decrease with increased
  pressure from 0.5 at 2 mTorr to 1 at vacuum.

Figure 2: The absolute density of atomic oxygen as a function of
  pressure oxygen flow rate. The measured data is compared to the model
  calculation of Schutz et al. (2006). The applied power was 150 W and the
gas flow rate 33.5 sccm. The inductive discharge chamber was made of
  stainless steel 20 cm in diameter and 10 cm long. The measured data is taken
  from Hsu et al. (2006).

Figure 3: The reaction rates for (a) the creation of the O(3P) atom
  versus fractional argon flowrate [Ar]/(Ar + O₂).

Figure 4: The reaction rates for (a) the creation of the O(3D) atom
  versus fractional argon flowrate [Ar]/(Ar + O₂).

Figure 5: The electron temperature versus pressure. The applied
  power is 500 W, the gas flow rate 50 sccm and the argon content 25 ,
  50 and 75 %.

Figure 6: The fractional dissociation versus the fractional argon
  flow rate.