

Non-CO₂ Greenhouse Gases: High-GWP Gases

Source/Sectors: Semiconductor Sector

Technology: Point-of-use plasma abatement (C.3.3)

Description of the Technology:

Plasma abatement technologies rely on the basic idea that larger exhaust molecules are broken into fragments in the plasma and then recombine in new ways, in the presence of other fragments, to form a new set of exhaust gases that may then be removed by existing waste-treatment systems. Thus, the high GWP gases react with fragments of the additive gas (H₂, O₂, H₂O, or CH₄) in the plasma and form low molecular weight by-products with little or no GWP. Wet scrubbers can then remove these product molecules (US Climate Change, 2005). The small plasma source are located in the foreline of an etch tool or in the gas line between the process tool and the main pump, and before the dry pump nitrogen purge such that it can access the undiluted exhaust stream (IEA, 2003).

The two widely used technologies are: the Litmas “Blue” and “Red”, and AMAT’s Pegasys™ POU unit. Litmas’s “Blue” uses an inductively coupled radio frequency plasma source to transform high-GWP exhaust gases from etchers, and the “Red” which transforms the exhausts from plasma-enhanced chemical vapor deposition chambers using microwaves. AMAT’s Pegasys™ POU unit integrates cold-plasma abatement technology with popular etchers, which makes the abatement unit transparent to process engineers (US Climate Change, 2005).

Effectiveness: Litmas reported emission reductions from 97% to 99% for its “Blue” POU device; AMAT’s capacity coupled device (Pegasys II™) claims typically more than 95% reduction in emissions (IEA, 2003).

Implementability: It can be applied to the entire etch processes without any interference to the process. It also requires very little floor space to install (US Climate Change, 2005).

Reliability: This option has been demonstrated to attain the reduction efficiency of more than 97% when water vapor is used as an additive gas (USEPA, 2001).

Maturity: Well developed and commercialized.

Environmental Benefits: High-GWP gas emission reduction

Cost Effectiveness:

Technology	Lifetime (yrs)	MP (%)	RE (%)	TA (%)	Capital cost	Annual cost	Benefits
Point-of-use plasma abatement ¹	5	55	97	10	\$50.81	\$1.45	\$0.00

Note: MP: market penetration; RE: reduction efficiency; TA: technical applicability; costs are in year 2000 US\$/MT_{CO₂-Eq.}

1: CEC (2005) & USEPA (2001)

Industry Acceptance Level: Currently, plasma abatement is believed to be the most popular option in the industry. It accounts for 55% of the total emission reduction in the etching sector, being the largest reduction option (US Climate Change, 2005).

Limitations: This option can be applied only for etch processes, which account for approximately 30% of fabrication emissions.

Sources of Information:

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