



COST Materials Action 529: Efficient Lighting for the 21st Century

Diagnostics for ceramic metal halide light sources: Industry needs

WG1 'Plasma diagnostics & modelling'

Meeting on X-ray & novel diagnostic methods for ceramic metal halide light sources

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HID lamp diagnostics - Industry needs

Diagnostics for HID lamps

Why are these measurements needed ?

- To give a better understanding of the energy balance
- To help improve lamp & system efficacy, stability & reliability



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HID lamp diagnostics - Industry needs

1. Plasma diagnostics

- Temperature distribution of the heavy particles
- Electron temperature distribution
- Elemental abundance as $f(\text{axial \& radial position})$: non-species specific
- Gas phase composition as $f(\text{axial \& radial position})$: species & state specific
- Concentration of contaminants (H_2 , H_2O , CO , CO_2)



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HID lamp diagnostics - Industry needs

2. Liquid dose diagnostics

- Elemental composition of the liquid dose
- Species within the liquid dose
- Gas composition above the liquid dose



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HID lamp diagnostics - Industry needs

3. Electrode & wall temperature diagnostics

- Electrode temperature distribution: time averaged as $f(\text{position})$, <0.1 mm resolution
- Electrode temperature distribution: resolution $<0.05(1/\text{op freq})$ & 0.1 mm spatial
- Wall temperature diagnostics: outer surface
- Wall temperature diagnostics: inner surface



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4. Ignition diagnostics

- Visualisation of the breakdown process with optical diagnostics
- Measurement of electron densities & electric fields
as $f(\text{axial \& radial position})$ during breakdown



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HID lamp diagnostics - Industry needs

5. Fundamental data

- Radiation properties of optically thick radiators (line broadening, transitions probabilities)
- Radiation properties of optically thin radiators (reduced emission coefficients)
- Diffusion coefficients & mobilities of plasma species
- Viscosities of buffer gases
- Thermochemical parameters for:
 - plasma species (discharge properties)
 - liquid - gas reactions (dose chemistry)
 - solid - gas reactions (corrosion)
 - solid - liquid reactions (corrosion)
- Kinetic parameters for material transport mechanisms



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Material properties

- Thermal stresses in glass-to-metal seal
- Thermal stresses in ceramic-to-metal seals
- Contamination in pinch cracks
- Effect of dopants on ceramic properties



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HID lamp diagnostics - Industry needs

Examples of predictive models needed

- Lamp voltage rise through life
- Lamp voltage & colour changes for vertical & horizontal operation
- Output from 200 to 3000nm
- Lamp life



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HID lamp diagnostics - Industry needs

Recommendations

- COST 529 Diagnostics databases
 - methods
 - facilities - confidentiality, timescales & costs must be realistic
 - short term scientific mission to initiate databases
- COST 529 standard lamps
- Conversion of academic methods to ‘everyday tools’ where appropriate



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Priorities

- Plasma diagnostics (1.1 to 1.5)
- Liquid dose diagnostics (2.1 to 2.3)
- Fundamental data (5.1 to 5.5)



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