Redesign of the Incandescent
Agenda

Advanced Lighting Technologies
   ADLT top line overview
   ADLT companies related to Hybrid Halogen (IR halogen)

Hybrid Halogen
   The technology: How it works
   Product benefits

The Hybrid Halogen Market
   PAR: Product performance vs. IRL requirements (June 2012)
       Directional efficiency vs. non-directional efficiency
   A-line: Product performance vs. EISA2007 standards
       Prototype testing
   MR16: Product performance

Prospects for Commercialization
   ADLT model
   Coating and capsule capacity
ADLT Overview

Energy efficient lighting materials and products

Hybrid coating equipment, services

Metal Halide Salts
HPS Amalgams

Precision Reflectors

Pulse Start
Metal Halide Lamps

Metal Halide Electrodes
HPS Electrodes

Joint Venture
ADLT Overview: Hybrid Halogen (IR Halogen)

Hybrid Capsule Coating Services and Coating Equipment

- Pioneered the application of coating for IR halogen
- Dominant world share
- Two industry leading technology platforms (PICVD and MicroDyn)
- Continued advancements in coating technology
- Coating services: Germany, expanding to Asia
- Coating equipment: California

Hybrid Capsules and Capsule Equipment

- Superior method of filament alignment
- Utilizes pre-coated formed bodies
- Single-ended and double-ended processes
- Achieves state-of-the-art performance
The Technology
Hybrid Halogen: The Technology

• **Precision filament**
  Recrystalized for rigidity

• **Optimized capsule**
  Smaller leg diameter = reduced end losses
  Halogen gas
  Correct geometry

• **Advanced thin-film coatings**
  In general, the better the coating, the better the gain

Visible light transmitted

ADLT thin film coatings

Reduced end losses

Infrared light reflected, absorbed by filament
Hybrid Halogen: The Technology

Efficacy Advances vs. Time

- Improved IR Filter, Capsule
- Improved IR Filter
- IR Filter
- Halogen
- Coiled Coils
- Drawn Wire
- Tungsten
- GEM Carbon

ADLT influence
Hybrid Halogen: The Technology

Hybrid Halogen Theoretical Limit for IR Recapture

Fraction of Recaptured Energy

Efficacy (lpw)

100
90
80
70
60
50
40
30
20
10
0

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Incandescent
Typical Hybrid Halogen
AULI Hybrid Technology

10% Gas & End Losses
8% Visible Light
Hybrid Halogen: The Technology

Benefits

Familiar Incandescent Light Quality
- 100 CRI
- Dimmable, motion sensor compatibility
- Same or smaller lamp configurations (e.g. PAR20 vs. PAR38)
- Instant light
- > 90% end of life performance

Associated as a safe product
- No mercury
- RoHS compliant

Great Directional Light Source
- Point source optics providing excellent MBCP / Watt
- Reduced heat

Energy Efficient. Yes, Energy Efficient
- Current potential for >50% energy savings
Hybrid Halogen PAR
Hybrid Halogen PAR: Improving Efficacy

DOE Final Rule: PAR30 & 38 IRL Efficacy Requirement 2012

- **Standard halogen**
- **Hybrid halogen (Commercial):** Capsule efficacy ~ 24 lpw at 70W. Aluminum reflector coating.
- **Hybrid halogen (Current Potential):** Capsule efficacy ~27.6 lpw. Silver reflector coating.

Min Efficacy (LPW) vs Watts graph

- **PAR 30/38 Efficacy Requirement 2012**
- 1350 lumens
Hybrid Halogen PAR Has Higher Directional Lumens (CBCP)

* ADLT prototype capsule (2,500+ hour life): Performance in EcoWhite Silver coated reflector (30-degree flood)
Directional lumen comparisons based on 30-degree flood
Hybrid Halogen MR16
Hybrid Halogen MR16

Improving Hybrid Halogen efficacy in medium to high lumen applications

Hybrid Halogen MR16
- Current: 37W Hybrid replaces 50W standard (800 lumens)
- 2012: 30W Hybrid replaces 50W standard (800 lumens)
- Market Focus: Medium to high lumens
  - Beam control
  - Dimmability
  - Color quality

LED MR16
- Will increase in lumen output
- Thermal limitations
- Light density limitations (in small MR16 configuration)

* LED performance based on 2010 DOE CALiPER and Lighting Facts and 3,000K CCT
Hybrid Halogen A-Line
**EISA2007 A-Line Minimum Efficacy Requirement by Watts**

- **Phase 1:** 2012-2014
  - 37 less watts
  - No lumen sacrifice
  - 1490 lumens

- **Phase 2:** 2020 minimum
  - 22 less watts
  - No lumen sacrifice
  - 1600 lumens

**Standards Comparison:**
- **Standard halogen**
- **Hybrid halogen (2011):** 50W = 100W
- **Hybrid halogen (By 2020):** 35W = 100W
Hybrid Halogen A-Line: High LpW with Long Life Demonstrated

Current Capsule Prototype (59W)
Lamp CCT: 2900
Life = ~3,000 hours
Capsule Efficacy = 31.5 lpw
Hybrid Halogen A-Line: 50W Replacement for 100W

Scheduled for 2011 Production

At 3,000 lamp CCT
Life = 1,000+ hours
Capsule Efficacy > 33 lpw
Supports A-Line 50W = 1600 lumens
Commercialization
ADLT: ‘Hybrid Halogen inside’

ADLT is supporting brand partners:

1. Advancing Hybrid Halogen technology
   • IR coatings
   • Coating and capsule interface
   • Capsule design
   • Manufacturing processes (faster, higher throughput, cheaper)

2. Building capacity
   • IR coating
   • Capsule
Hybrid Halogen Commercialization

Key: Hybrid Halogen capsule capacity

Capacity

Hybrid Coatings
- Coating services
- Coating equipment
- Pre-coated bodies

Hybrid Capsules
- DE for A-line, PAR, BR
- SE for MR16

PICVD Coating
MicroDyn Coating
Capsule Manufacturing
Hybrid Halogen Commercialization

Coating Capacity

- Germany: Expanding capacity, facilities
- India: Facilities in place
  First coating operations 2011
- China: Coating operations 2012

Capsule Capacity

- Turnkey manufacturing equipment
- Key materials

PICVD coating - Germany

Coating bays – India operations
Hybrid Halogen

“The Peoples Choice” – The only transparent replacement for the incandescent lamp
  • Energy Efficient
  • Dimmable
  • No Mercury
  • High Quality Light
  • Instant On

ADLT is driving the pace of Hybrid innovation
  • Performance
  • Cost
  • Availability

Hybrid Halogen is one leg of the energy efficient offering to the consumer channel
  • Hybrid Halogen
  • CFL
  • LED