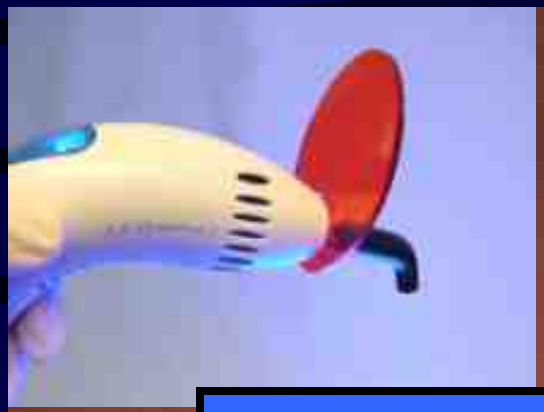


New Dental Products

Kraig S. Vandewalle, DDS, MS
Col, USAF, DC
Director, Materials Evaluation Dental Investigation Service

New Products

- Curing lights
- Bonding Agents
- Composite Resins

Curing Lights

- White light
  - filtered down
    - halogen
    - plasma-arc
- Blue light
  - at the source
    - argon laser
    - LED

Quartz-Tungsten-Halogen

- Most common dental curing light
- Quartz
  - encasing structure
  - crystalline
  - heat resistant
- Tungsten
  - filament coil
  - flow of electricity

Quartz-Tungsten-Halogen

- Halogen gas
  - protects filament
    - oxidation
  - re-deposits tungsten to filament
    - “halogen cycle”

Quartz-Tungsten-Halogen

- Radiant output
  - infrared energy (IR)
    - heat
- Cooling critical
  - do not turn off fan
    - halogen gas lost
    - oxygen enters
    - bulb life dramatically decreases

Quartz-Tungsten-Halogen

- Filters
  - band-pass
    - restricts to narrow visible light
      - 400 – 500 nm
      - range of photo-initiators
  - 99.5% of original radiant energy filtered
    - inefficient

Quartz-Tungsten-Halogen

- Filters
  - dichroic
    - silver reflective surface
    - passes IR energy
    - reflects visible light
    - provides focal spot
- QTH bulb
  - 30 – 50 hours useful life
  - $30 - $80

Quartz-Tungsten-Halogen

- Demetron LC
  - inexpensive ($250)
  - simple
  - 600 mW/cm^2
- Optilux 501
  - cost $975
  - powerful (1200 mW/cm^2)
  - variable modes

Halogen: Reloaded

- Swiss Master Light
  - 3000 mW/cm^2
  - water-cooled bulb
  - disposable light guide
  - expensive
    - $2900

Plasma-Arc (PAC)

- Two tungsten electrodes
  - small gap
- Pressurized chamber
  - xenon gas
- High-voltage spark
  - ionizes gas
    - plasma

Plasma-Arc (PAC)

- High levels of IR and UV
  - extensive filtering
    - down to 400-500 nm
  - remote light source
    - liquid-filled light cord
    - fiber-optic cord

Plasma-Arc (PAC)

- High irradiance
  - > 2000 mW/cm^2
  - claim 1-3 sec cure
    - DIS – 10 secs
- Expensive
  - $3,000 - $4,995
    - bulbs >$500
    - hard to replace
  - Apollo 95E (DMD)
  - Sapphire (Den-Mat)
  - PAC Light (ADT)

Argon Laser

- High energy
  - coherent, non-divergent
  - non-continuous
- Expensive
  - $6000 - $9000
- Accucure 3000 (Laser Med)

Light-Emitting Diodes (LED)

- Semiconductors
  - electrically-excited atoms
- Gallium-nitride blue
- Narrow spectrum
  - 430 – 490 nm
    - peak at 470 nm
    - near absorption max of camphoroquinone

Jandt Dent Mater 2000

LED Curing Lights

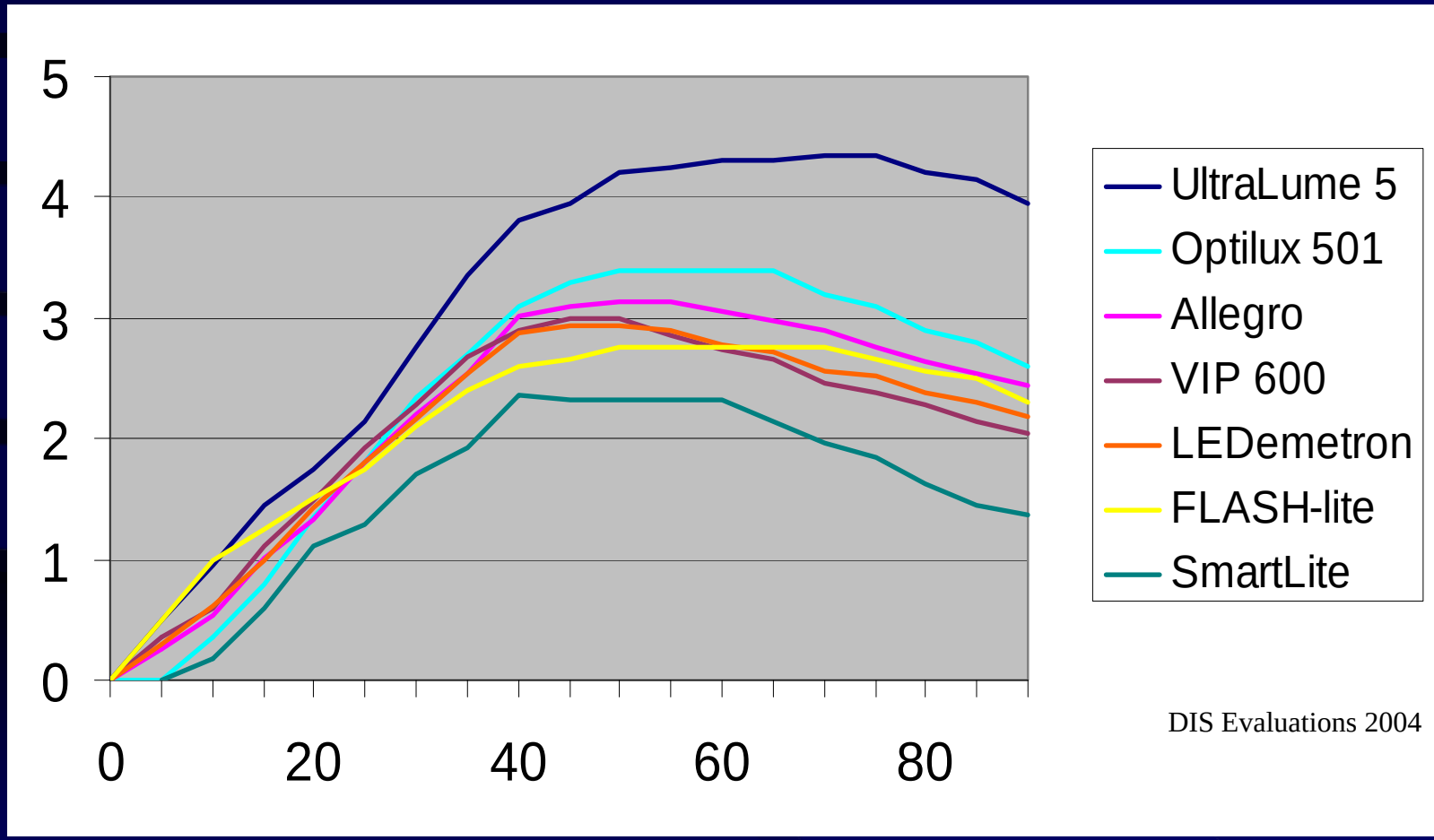
- Long lasting light source
  - minimal bulb aging
  - minimal decrease in output
- Less lateral heat production
  - minimal or no fan necessary
- No filters
- Typically cordless

Freelight

Duke Compendium 2001

Increase in Temperature

(pulpal)



DIS Evaluations 2004

LED Curing Lights

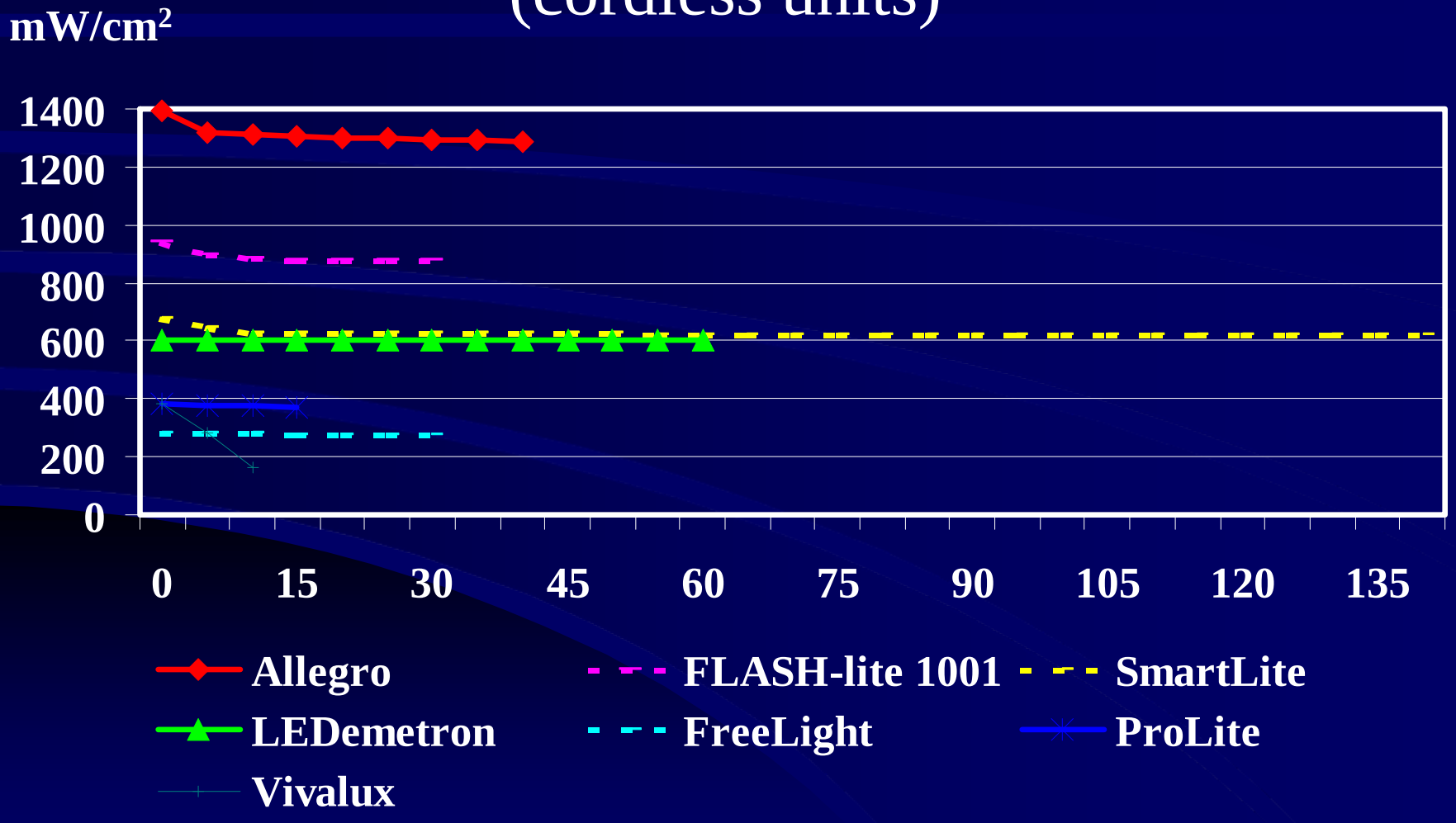
- First generation
  - cost
    - $1000 - $1500
  - low irradiance
    - < 300 mW/cm^2
    - increase exposure time
  - NRG (Caulk)
  - Versalux (Centrix)
  - Zap (CMS)

LED Curing Lights

- Second generation
  - cost
    - $540 - $1295
  - higher irradiance
    - > 600 mW/cm^2
  - L.E.Demetron 1 (Kerr)
  - SmartLite iQ (Dentsply)

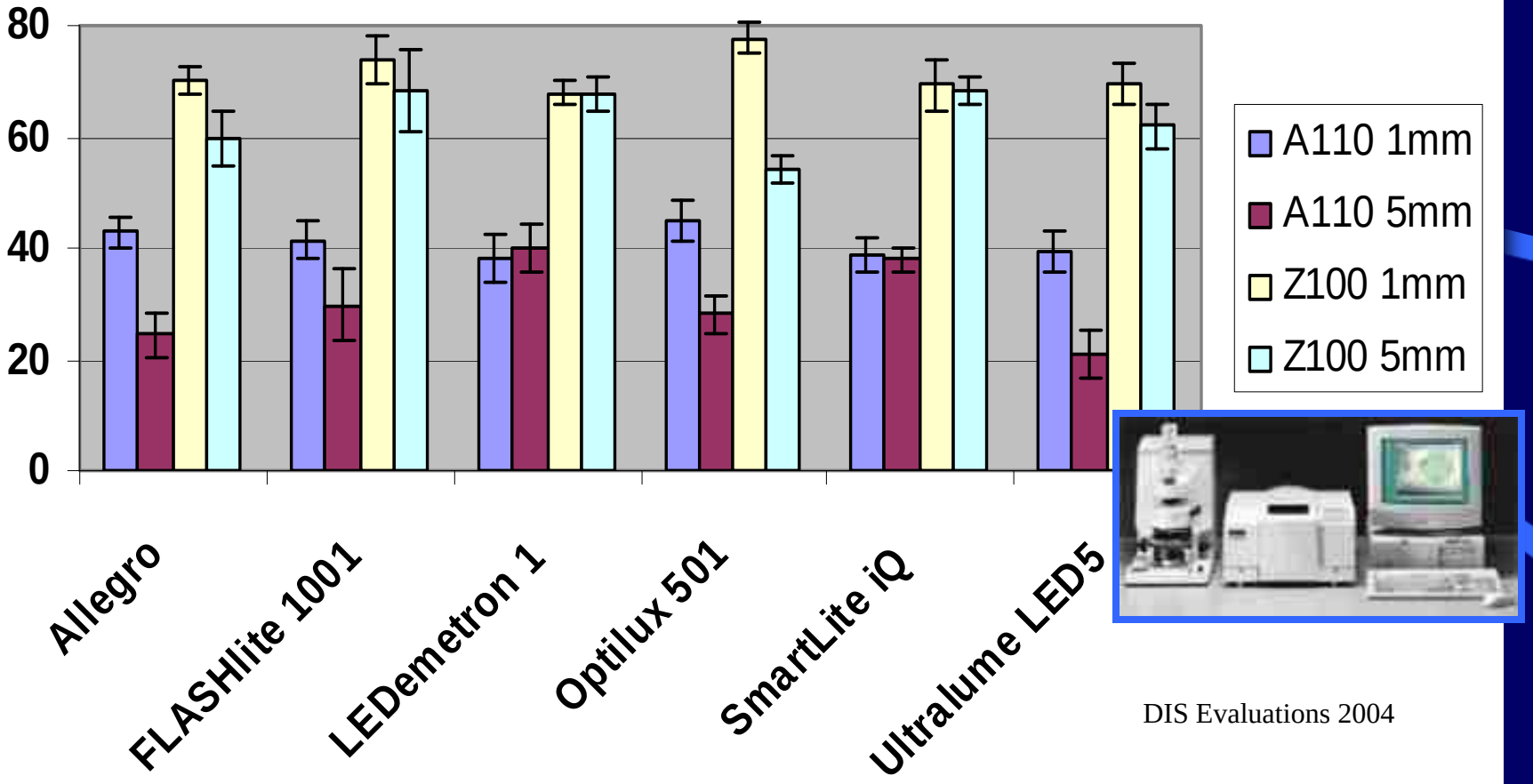
Discharge Time on Irradiance

(cordless units)



% Degree of Conversion Ratio

2 mm composite for 5 seconds



DIS Evaluations 2004

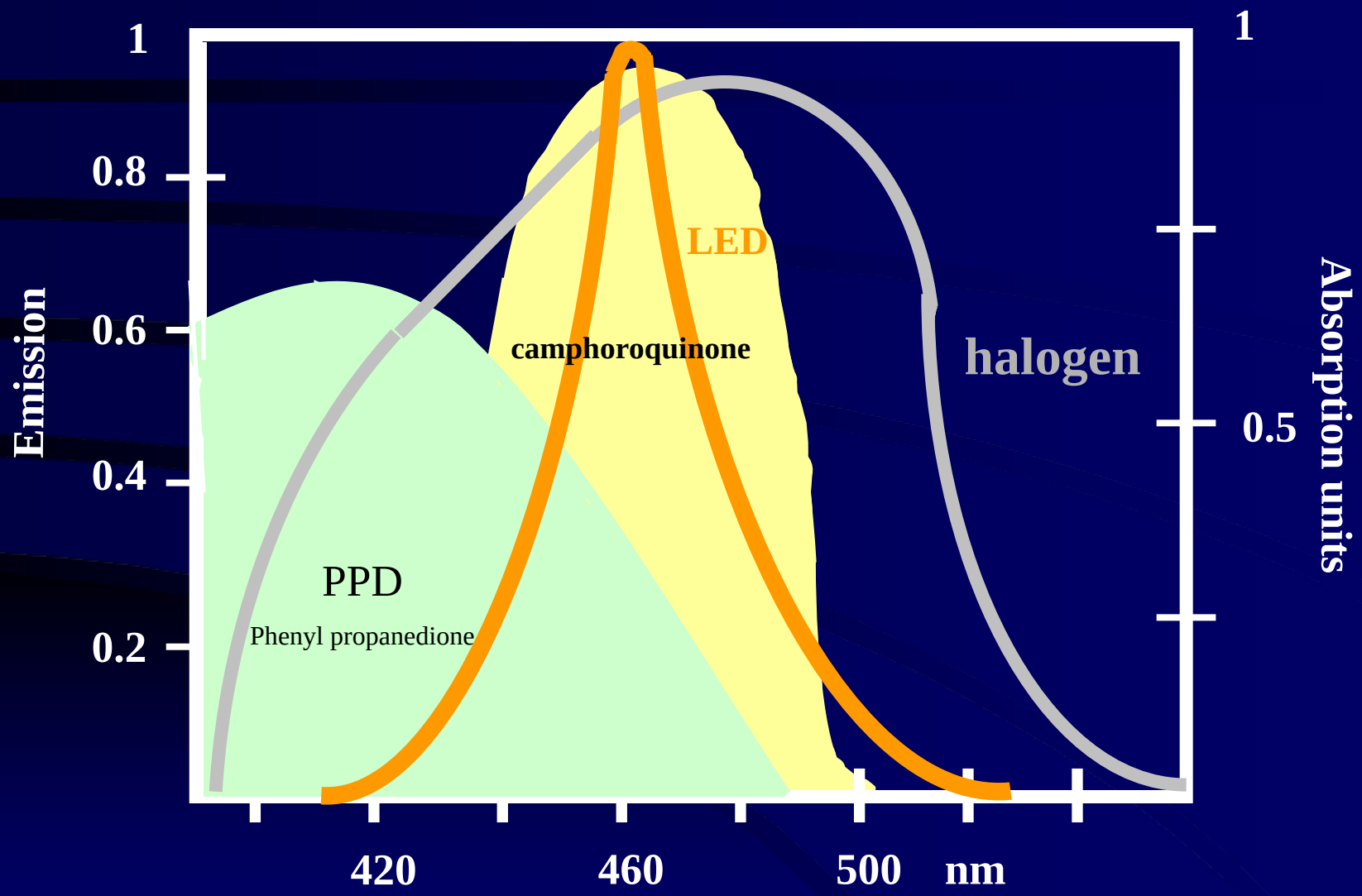
Light Projections

DIS Evaluations 2004

New Developments

- Narrow spectrum lights
  - argon laser
  - LED
- Other photoinitiators absorb at lower wavelengths
  - PPD
  - TPO
- Narrow spectrum lights may not polymerize materials containing other initiators

Spectral Emission / Absorption



Althoff Amer J Dent 2000

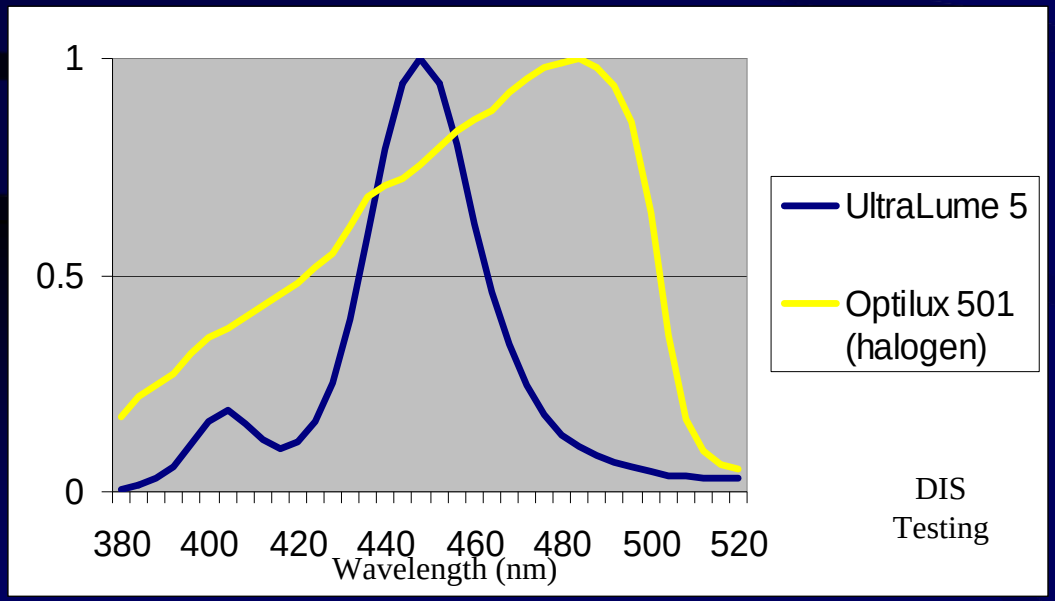
LED – Resin Incompatibilities

- Products
  - Biscover (Bisco)
  - Cabrio (Discus Dental)
  - Principle (Dentsply)
  - Pyramid (Bisco)
    - neutral & translucent

CRA Newsletter 2003

Multi-Spectrum LED Light

- UltraLume LED 5 (Ultradent)
  - bimodal emission spectrum
    - cures all photo-initiated materials



Selecting a Light

- Basic features
  - irradiance
  - cost
- Convenience features
  - built-in radiometer
  - timer
  - interchangeable tips
  - ease of maintenance

Purchasing Considerations
Federal Service

- Halogen
  - established technology
  - relatively inexpensive
  - multiple curing modes
  - poor efficiency
    - heat
    - fan
  - limited bulb life

Optilux 501
(halogen)

- Cures ALL resins
- High irradiance
  - >1000 mW/cm^2
- Built-in radiometer
- Multiple tips available
- Noisy fan
- Inefficient
- More expensive

Product of the Year 2001

5-Stars 2002

Purchasing Considerations

Federal Service

- LED
  - similar curing to halogen
  - lightweight and quiet
  - longer LED “source” life
  - more efficient
    - less lateral heat
      - little or no fan necessary
  - may not polymerize all photo-initiated materials
  - batteries may have to be replaced

LEDemetron 1

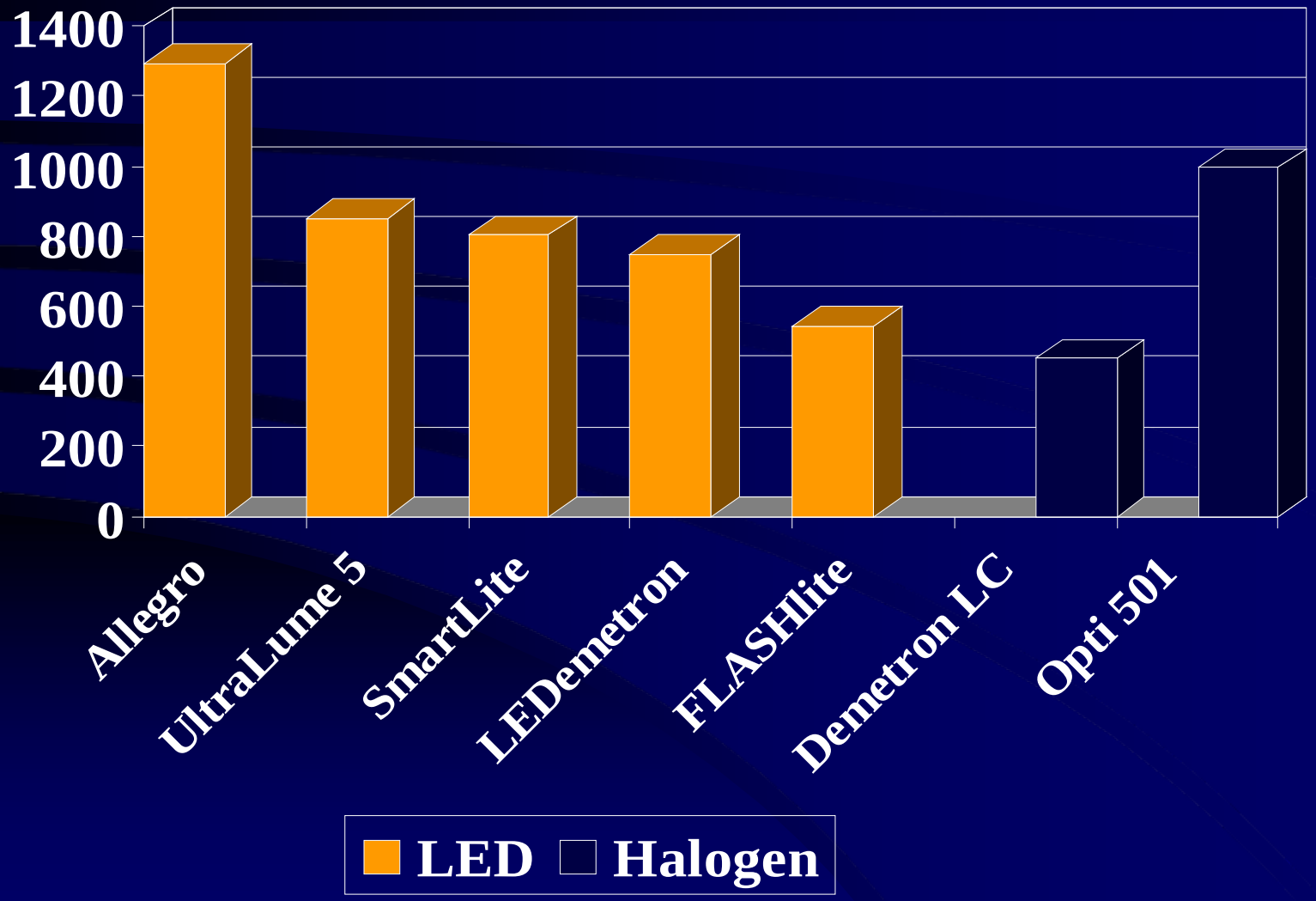
- Cordless handpiece
  - fan
  - removable light guides
- Battery charger
- 2 rechargeable batteries
  - removable
- Retail: $1200.00
- Government: $750.00
- Rated “Recommended” by DIS

SmartLite iQ

- Cordless handpiece
  - no fan
  - rechargeable battery
  - removable light guides
- Battery charger
- Retail: $1100.00
- Government: $803.00
- Rated “Recommended” by DIS

Price Comparisons

(Government)



Purchasing Considerations

Federal Service

- Plasma Arc
  - shorter curing times
  - more expensive
  - higher heat potential
- Argon Laser
  - very expensive
  - excellent collimation
  - impractical for routine use

Bonding Agents

- Total-etch (etch&rinse)
- Self-etch

Etch & Rinse (Three-Step)

- Conditioner
- Primer
- Adhesive resin

- Examples
  - Scotchbond Multi-Purpose
  - Optibond FL

Conditioner

- Chemical alteration of surface
  - acids
    - phosphoric, citric, maleic, nitric
- Removes dentinal smear layer
    - exposes collagen fibrils
- Simultaneous enamel etch
- Rinse
  - keep moist

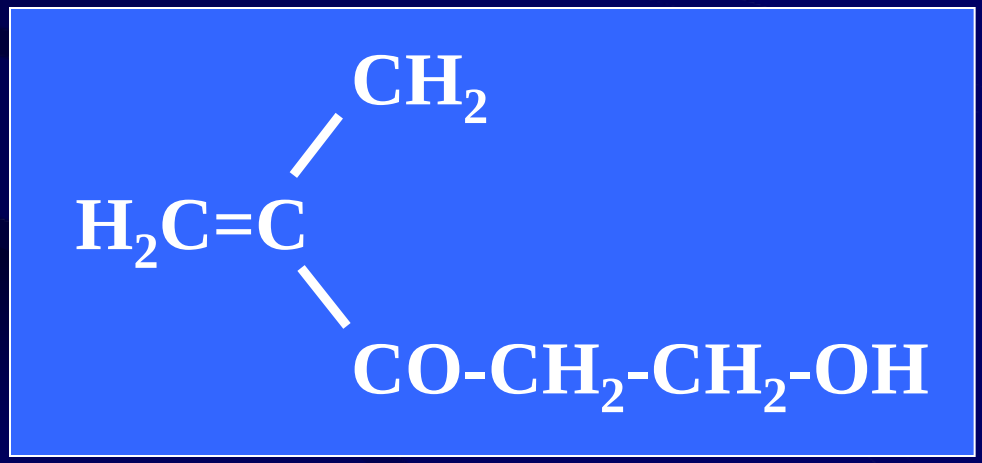
Primer (wetting agent)

- Hydrophilic monomers
  - dissolved in acetone, alcohol or water
- Displaces water
- Promotes infiltration into collagen
- Lightly air dry
  - drive off solvents, water
- Transforms hydrophilic to hydrophobic

Swift JADA 1994

Primer (wetting agent)

- Bifunctional monomer
  - Link
    - hydrophilic collagen
    - hydrophobic resin
  - HEMA
  - 4-META
  - BPDM
  - PMDM



Adhesive Resin

- Unfilled or lightly-filled monomers
  - Bis-GMA, UDMA, TEGDMA
- Stabilize the hybrid layer
  - fills up remaining pores
- Resin tags
- Links primer to resin composite
  - typically light cured

Etch & Rinse (Two-Step)

- Conditioner
- Combined primer and adhesive
  - higher technique sensitivity
    - higher solvent-to-monomer ratio
      - risk of applying too thin
      - apply multiple layers
- Single Bond, Optibond Solo Plus, One Step

Pros/Cons of Etch & Rinse

- Separate 37% phosphoric acid etch
  - good enamel etch pattern
- Potential to over-etch dentin
  - except sclerotic dentin
- Post-conditioning rinse necessary
  - sensitive to level of dentin wetness
- Multiple long-term clinical studies available

Dentin Wetness

Etch & Rinse

- After conditioning dentin
  - dentin must be wet
    - prevent collagen collapse

Hybridoid Zone

- Too little water
  - collagen collapse
- Ineffective resin penetration
- Leads to nanoleakage

Sano Oper Dent 1995

Class V Clinical Studies

Etch & Rinse Three-Step

- Scotchbond MP (3M ESPE)
  - 100% retention at 3 yrs
    - Van Meerbeek Quint Int 1996
  - 98-100% retention at 3 yrs
    - Trevino JDR 1996
  - 100% retention at 2 yrs
    - Alhadny Am J Dent 1996

Class V Clinical Studies

Etch & Rinse Two-Step

- Optibond Solo (Kerr)
  - 93.3% retention at 3 yrs
    - Swift JADA 2001
- Prime & Bond 2.1 (Caulk)
  - 89.4% retention at 3 yrs
    - Swift JADA 2001

Three-step

$4.50 / ml

Two-step

$11.12 / ml

$9.42 / ml

$13.23 / ml

Prices current as of 04/03

Self-Etch (Two-Step)

- Combined conditioner and primer
- Adhesive resin

- Clearfil SE
- Optibond SE
- AdheSE

Self-Etch (One-Step)

- Combined
  - conditioner
  - primer
  - adhesive
- Examples
  - Prompt L-Pop
  - One-up Bond F
  - Touch and Bond
  - iBond
  - Xeno III

Self-Etch Components

Acidic monomers →
MDP
Di-HEMA-Phosphate
MA 154
Phenyl-P
MAC-10
4-MET(A)

Crosslinking monomers →
Bis-GMA
UDMA
TEGDMA
GDMA
HEMA

Solvent →
water based

Pros/Con of Self-Etch

- Good dentin conditioning
  - simultaneous infiltration
    - depth of demineralization
- Possible reduction in post-op sensitivity?
- No post-conditioning rinse
  - not sensitive to level of dentin wetness

Perdigao Am J Dent 1997

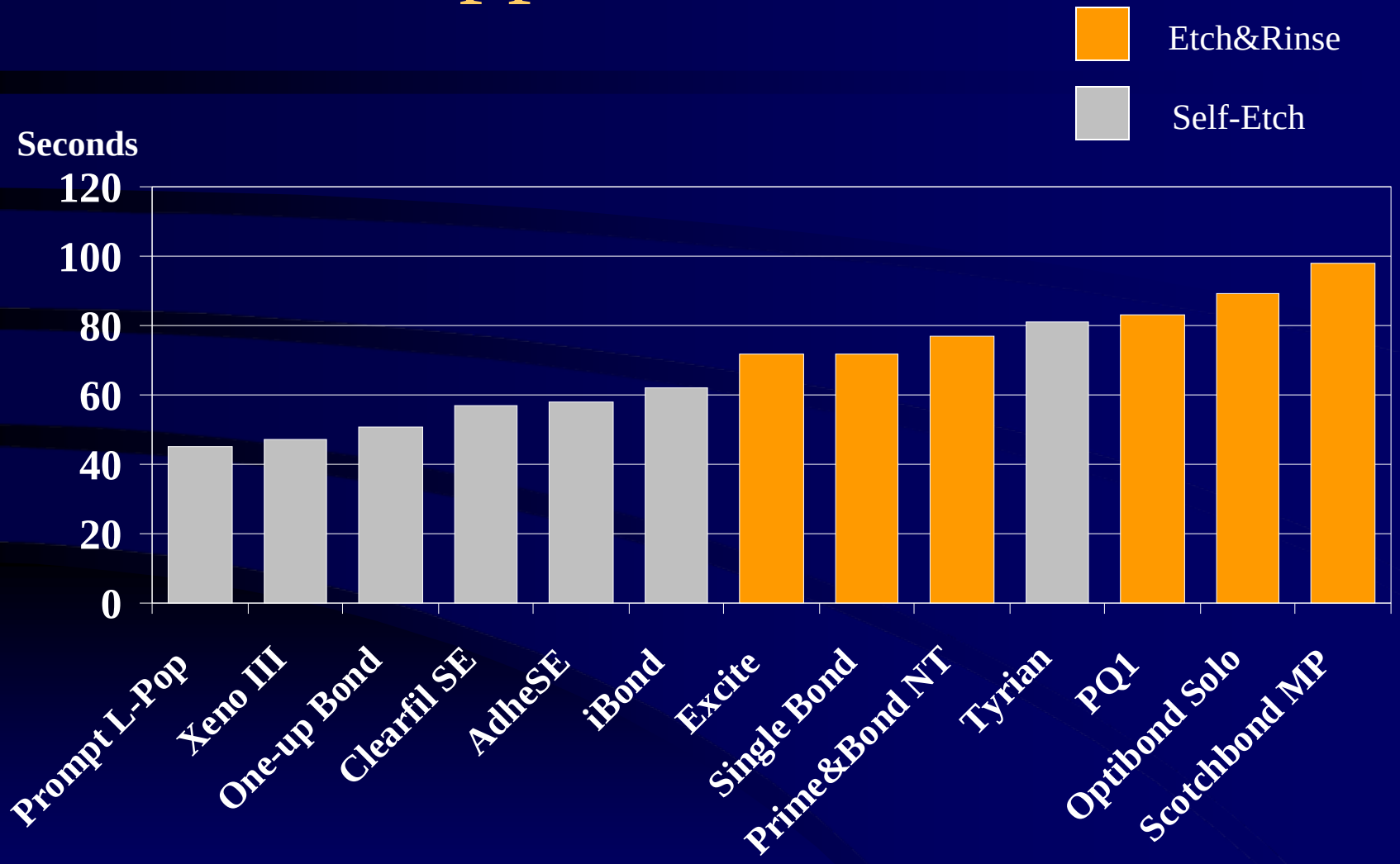
Hara Am J Dent 1999

Clinical Study

- 66 Class 1 or 2 composite restorations
  - Clearfil SE
    - self-etch
  - Prime & Bond NT
    - etch & rinse
- Tested for post-op sensitivity
- No difference
  - Baseline, 2 weeks, 6 weeks, 6 months

Perdigao Oper Dent 2003

Application Time

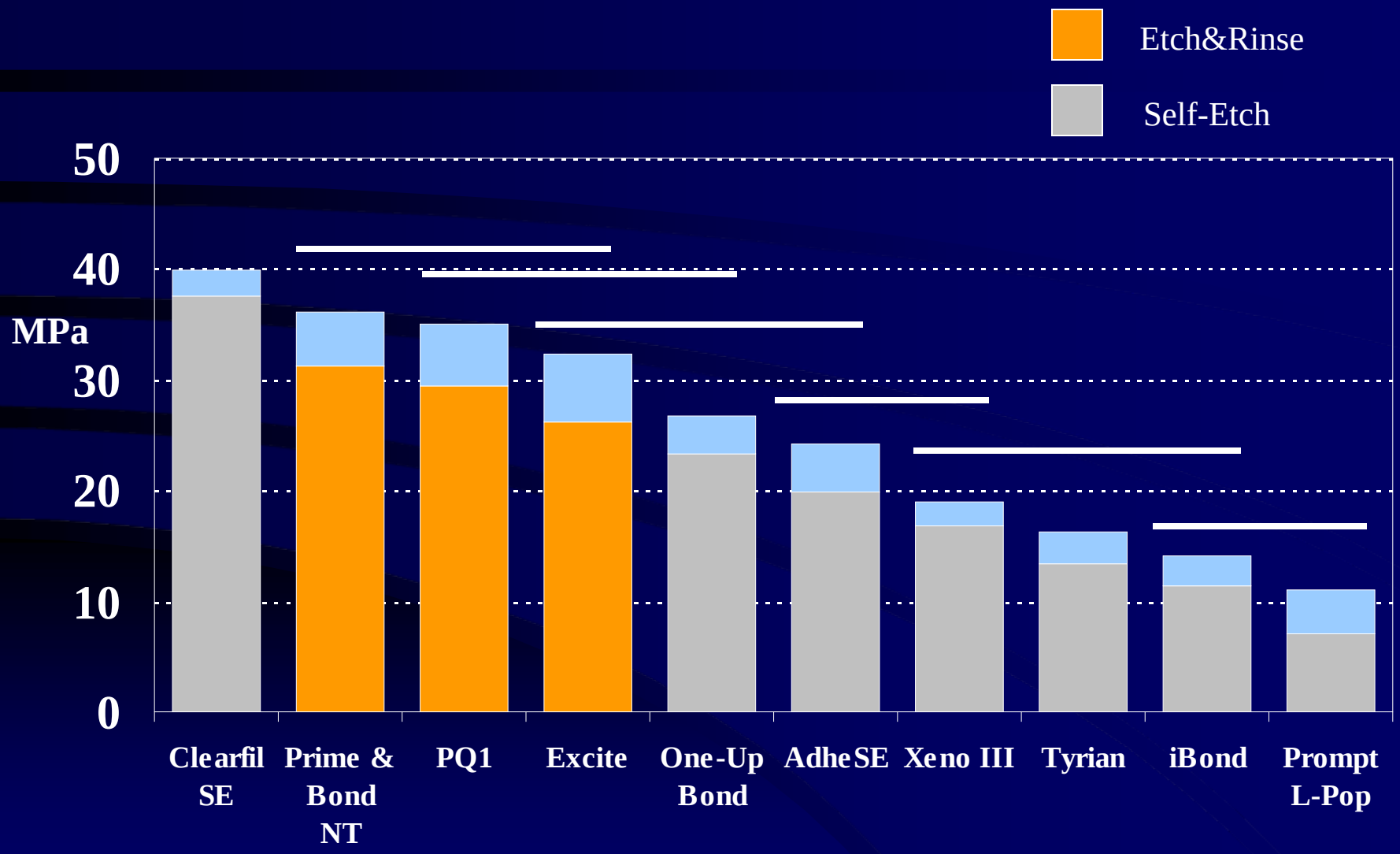


Source: USAF DIS N=3

Pros/Con of Self-Etch

- Potential under-etch enamel
  - equal or reduced enamel bonding
- Smear layer dissolved into resin
- Limited clinical data

Shear Bond Strength to Dentin



Source: USAF DIS Horizontal lines connect nonsig diff at 0.05 level

Class V Clinical Studies

Self-Etch Two-Step

- Clearfil SE Bond (Kuraray)
  - 100% retention at 2 yrs
    - Peumans J Dent Res abstr #0911
  - 93% retention at 2 yrs
    - Turkun J Dent 2003

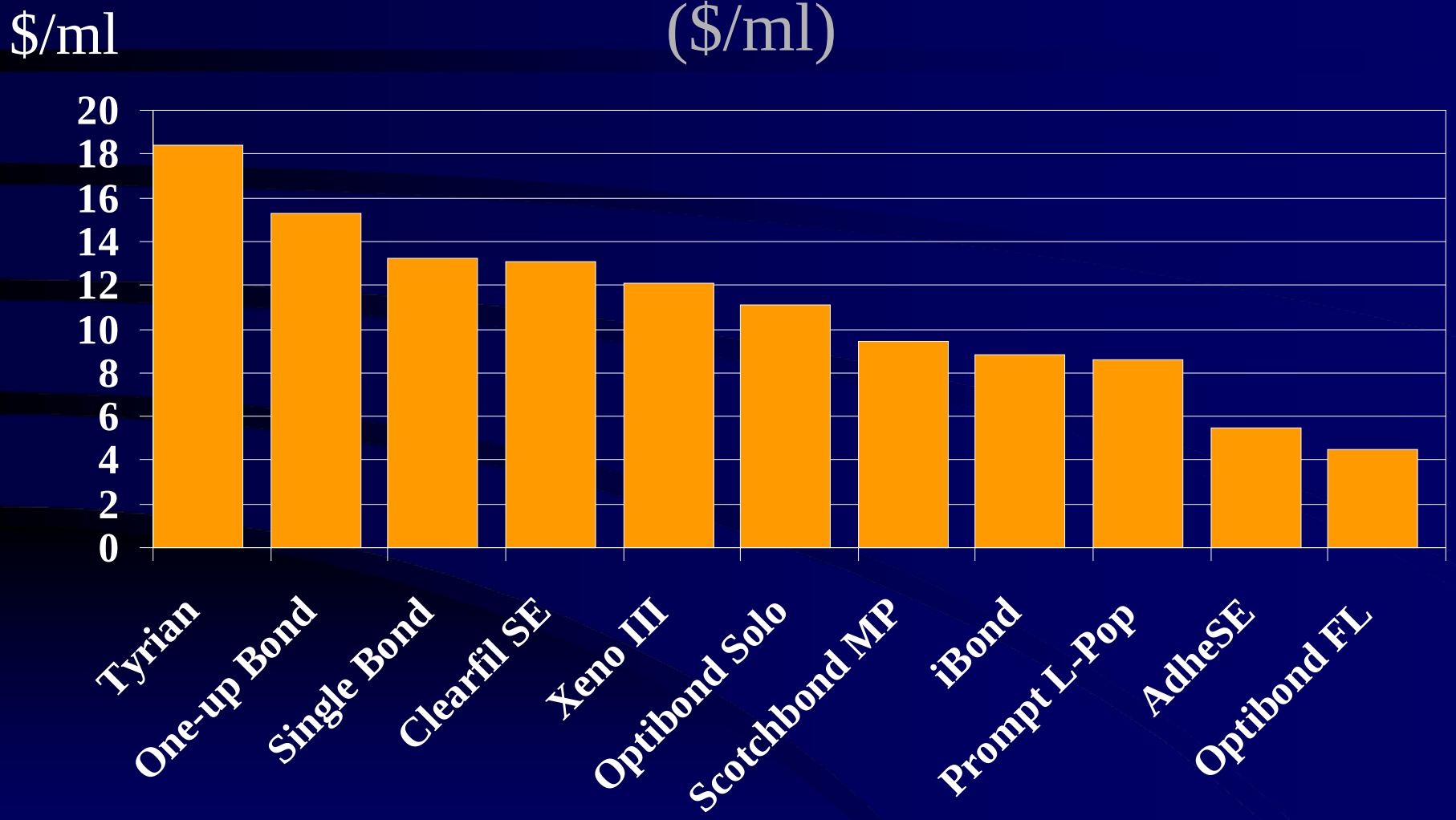
Class V Clinical Studies

Self-Etch One-Step

- Prompt L-Pop (3M ESPE)
  - 65% retention at 1 yr
    - Brackett Oper Dent 2002
  - 79% retention at 2 yrs
    - van Dijken EFOS abstr #8

Government Prices

($/ml)



Prices as of 11/03

Recommendations

- 4th generation
  - etch & rinse three-step
    - Scotchbond MP Plus
    - Optibond FL
- 5th generation
  - etch & rinse two-step
    - Optibond Solo Plus
    - Single Bond
    - Excite

Recommendations

- 6th generation
  - self-etch two-step
    - Clearfil SE Bond
  - self-etch one-step ?????

“Although there is a tendency toward adhesives with simplified application procedures, simplification does not guarantee equal or improved bonding effectiveness.”

Van Meerbeek Oper Dent 2003

Composite Resins

- Multiple shades/opacities
- Nanofilled

Classification System

- Chronological
- Based on particle size
  - traditional
  - microfilled
  - small particle
  - hybrid

Lutz J Prosthet Dent 1983

Microfills

- Better esthetics and polishability
- Tiny particles
  - 0.04 micron colloidal silica
  - increases viscosity
- To increase filler loading
  - filler added to resin
  - heat cured
  - ground to large particles
  - remixed with more resin and filler

Microfills

- Lower filler content
  - inferior mechanical properties
    - increased fracture potential
    - lacks coupling agent
- Linear clinical wear pattern
- Suitable for Class 3, 5
  - exceptions
    - Heliomolar RO in Class 1 or 2
    - overlay hybrid in Class 4
- Examples: Filtek A110, Heliomolar RO

Hybrids

- Popular as “all-purpose”
- 0.4 to 1 micron average particle size
  - distribution of particle sizes
    - maximizes filler loading
  - microfills added
    - improve handling
    - reduce stickiness

Hybrids

- Strong
- Good esthetics
  - polishable
- Suitable
  - Class 1 to 5
- Examples:
  - Z250
  - Prodigy

Newer Classification System

- Based on particle size
  - megafill
    - 0.5 - 2 millimeters
  - macrofill
    - 10 - 100 microns
  - midifill
    - 1 - 10 microns
  - minifill
    - 0.1 - 1 microns
  - microfill
    - 0.01 - 0.1 microns
  - nanofill
    - 0.005-0.01 microns
- Most new systems
  - minifillers
- Newest trend
  - nanofillers
  - trimodal loading
    - prepolymerized

Bayne JADA 1994

Placement Techniques

- Shaded
- Anatomic

Placement Techniques

- Shaded
  - 4 Seasons
  - Esthet-X
  - Filtek Supreme
  - Point 4
  - Venus
  - Renamel
  - Gradia Direct
- Anatomic
  - 4 Seasons
  - Vitalescence
  - Miris

Recent DIS Evaluations

- Venus (Heraeus Kulzer)
- 4 Seasons (Ivoclar Vivadent)
- Gradia Direct (GC America)
- Filtek Supreme (3M ESPE)

Venus

- Filler particles
  - average: 0.7 microns
  - filled: 61% vol / 78% wgt
- Kit very complete
  - 27 shades
    - 3 opacities
  - shade guide
    - layered with actual composite
- Moderate cost
- Rated “acceptable” by DIS

4 Seasons

- Filler particles
  - average: 0.6 microns
  - filled: 76% wgt
- Kit very complete
  - 40 shades
- Very inexpensive
- Rated “acceptable” by DIS

Gradia Direct

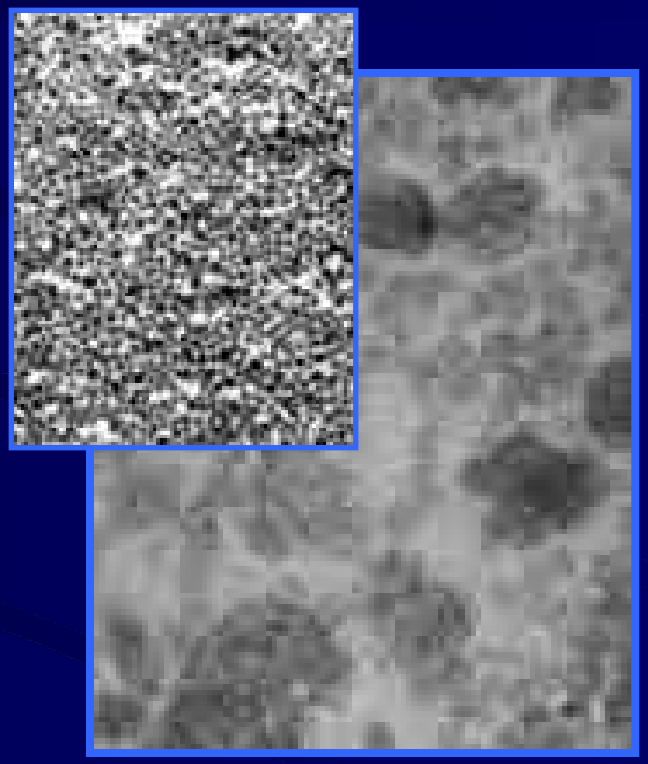
- Filler particles
  - average: 0.85 microns
- Anterior and posterior shades
  - 26 shades
- Inexpensive
- Rated “acceptable” by DIS

New Nanofilled Composites

- Nano-filled
  - 1 nm = 1/1000 micron
- Universal
  - strength of a hybrid
  - polish of a microfill
- Examples
  - Filtek Supreme (3M ESPE)
  - Simile (Pentron)

Filtek Supreme

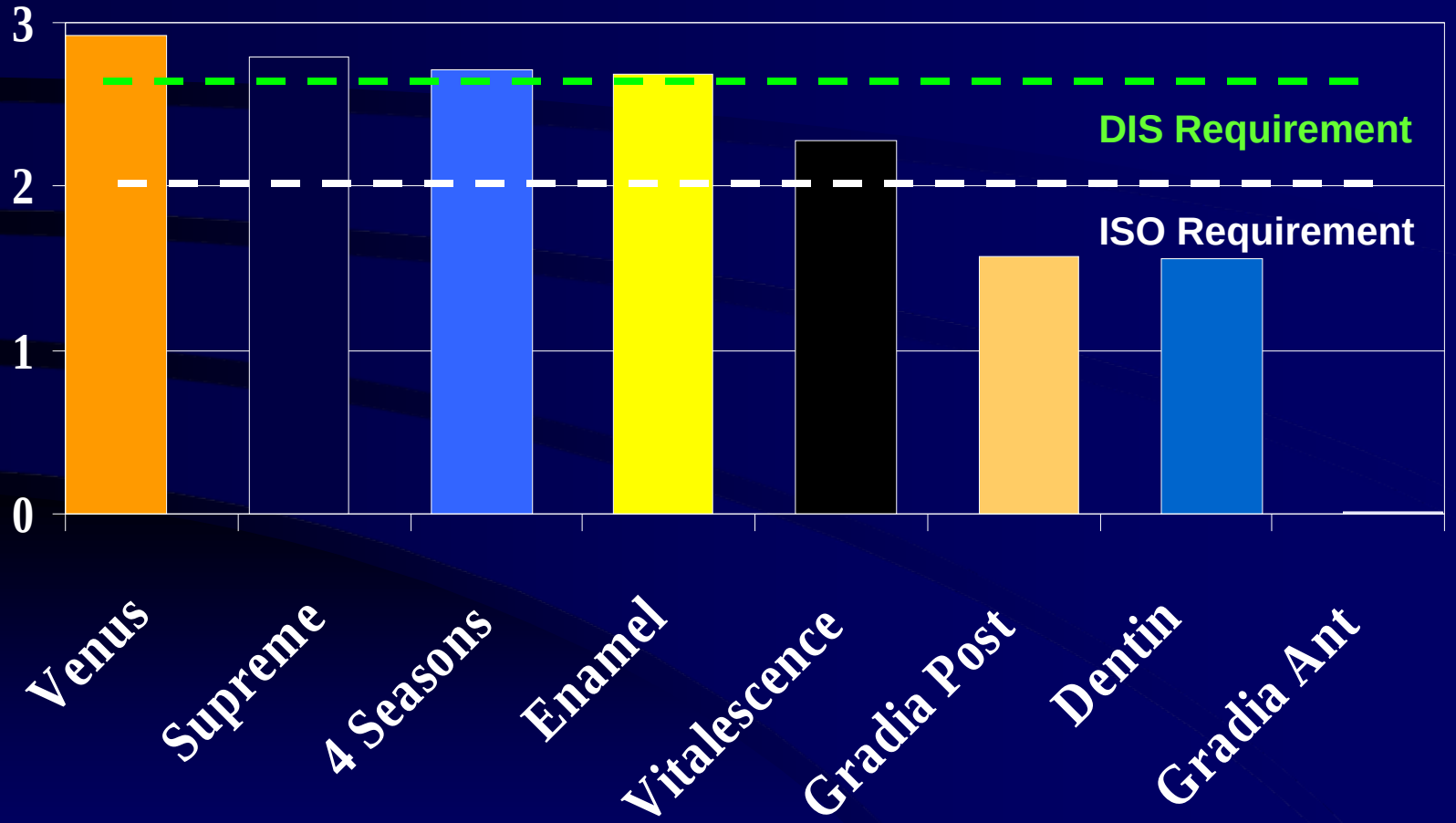
- Filler particles
  - filled: 78% wgt
  - nanomers
    - 0.02 – 0.07 microns
  - nanocluster
    - act as single unit
      - 0.6 – 1.4 microns



Filtek Supreme

- 30 shades
  - 4 opacities
  - only 12 in profession kit
- No shade guide
  - use Vita
  - shade wheel
    - layering
- Most expensive composite evaluated
- Rated “acceptable” by DIS

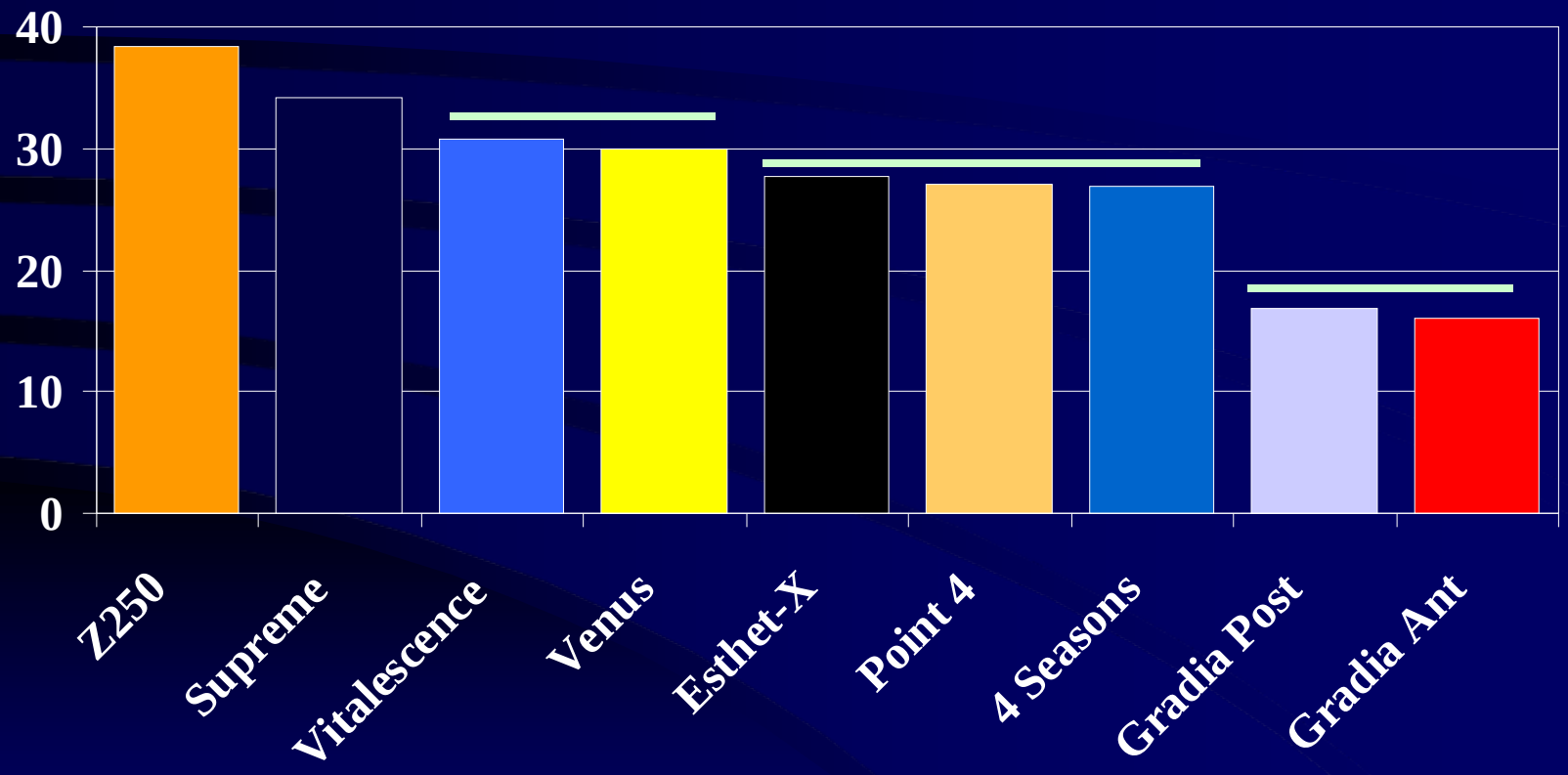
Radiopacity
(mm of aluminum)



Source: USAF DIS Project 03-037

Knoop Hardness
(24 hrs)

Source: USAF DIS Project 03-37

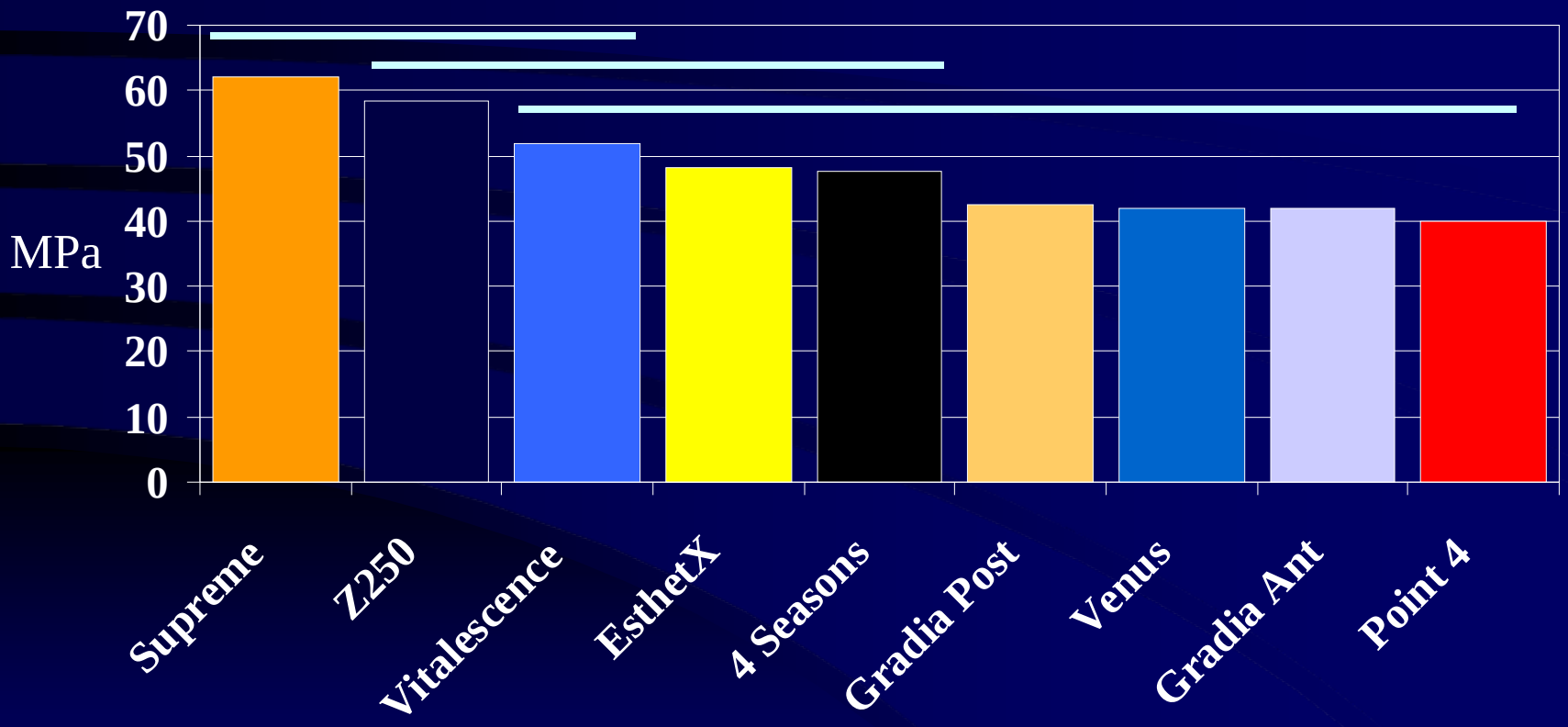


Horizontal lines connect nonsignificant differences (p<0.05); N=5

Diametral Tensile Strength

(24 hrs)

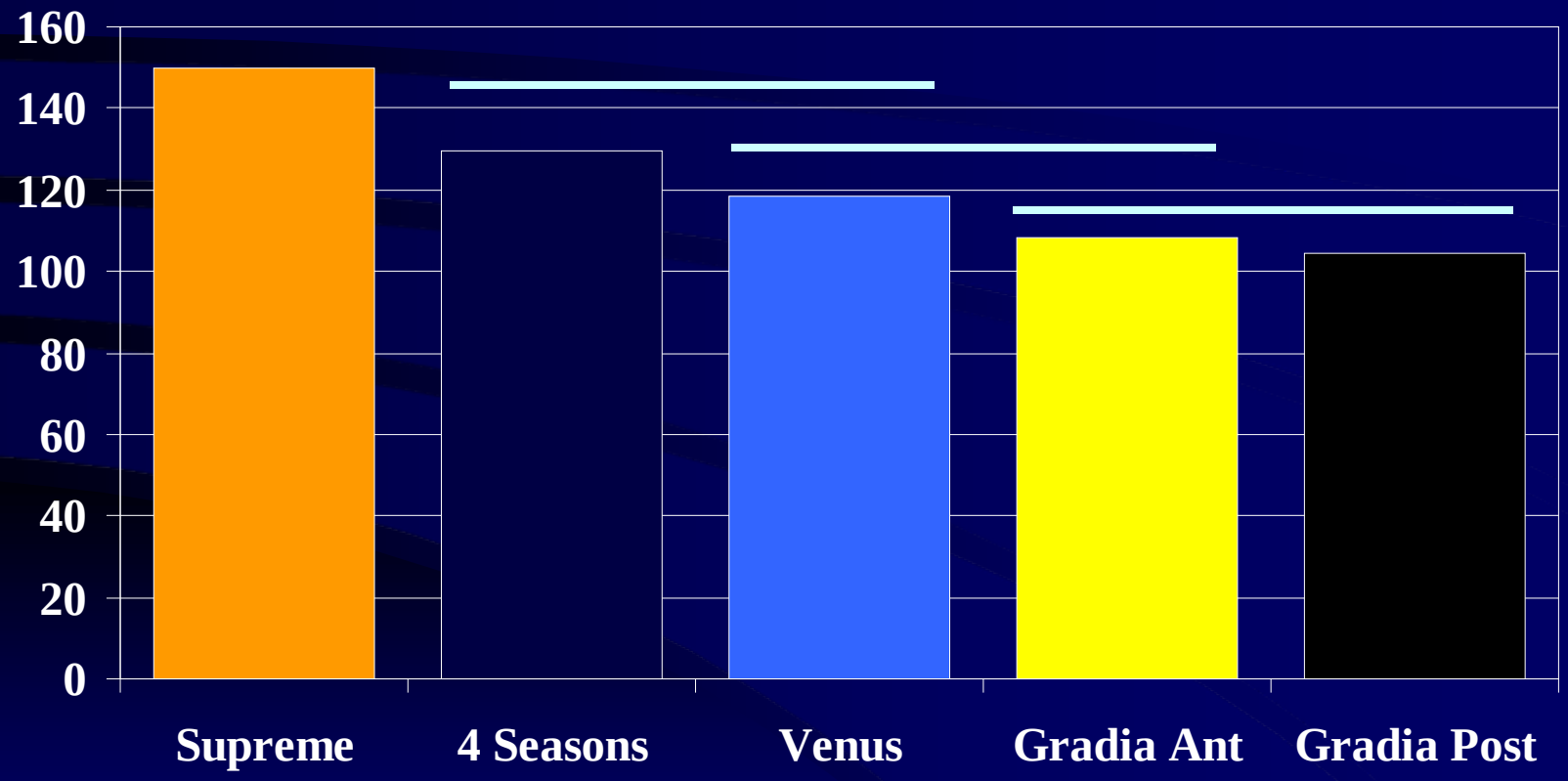
Source: USAF DIS Project 03-037



Horizontal lines connect nonsignificant differences (p<0.05); N=5

Flexural Strength
(24 hrs)

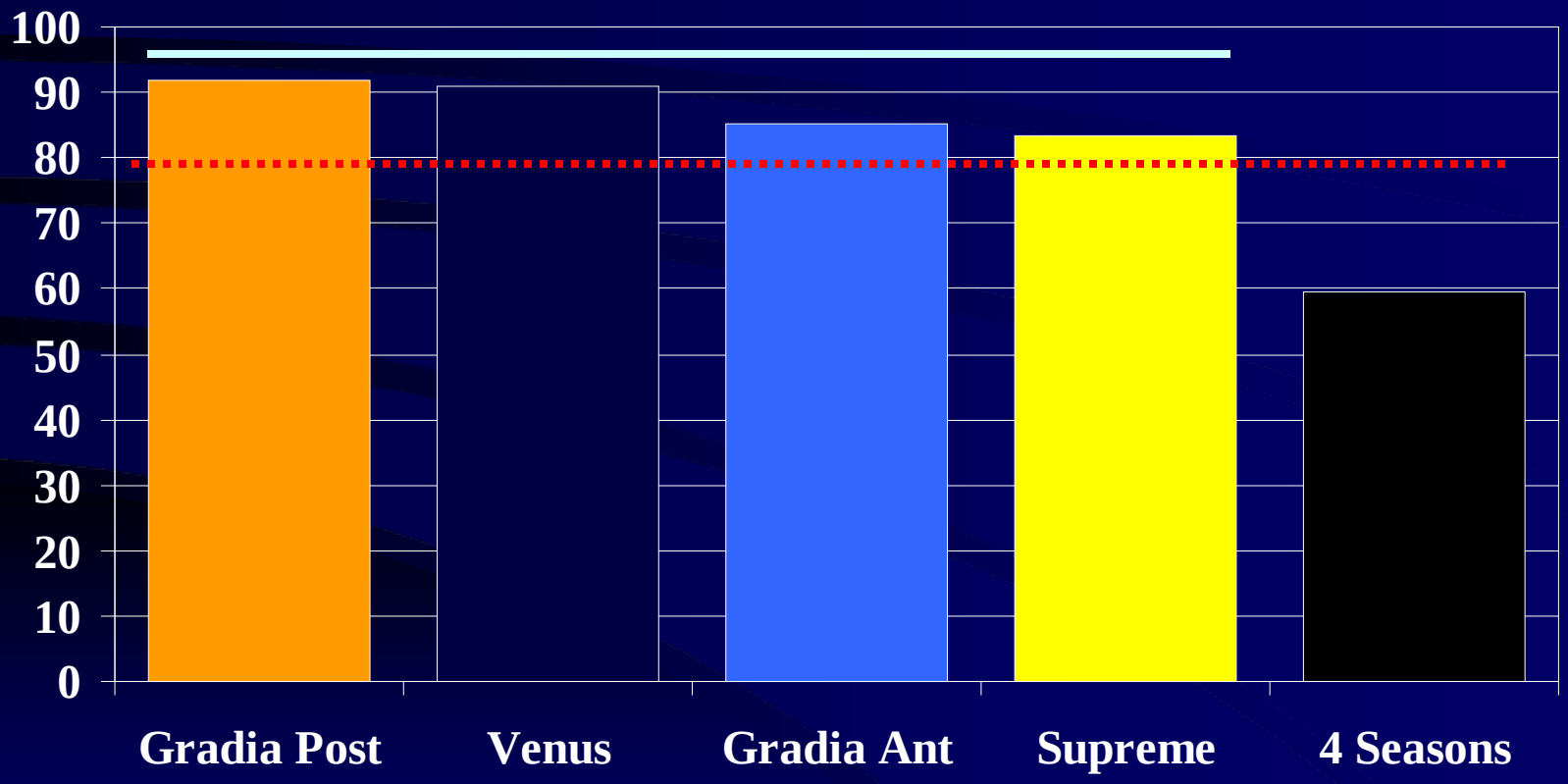
Source: USAF DIS Project 03-037



Horizontal lines connect nonsignificant differences (p<0.05); N=5

Depth of Cure
(% KHN ratio)

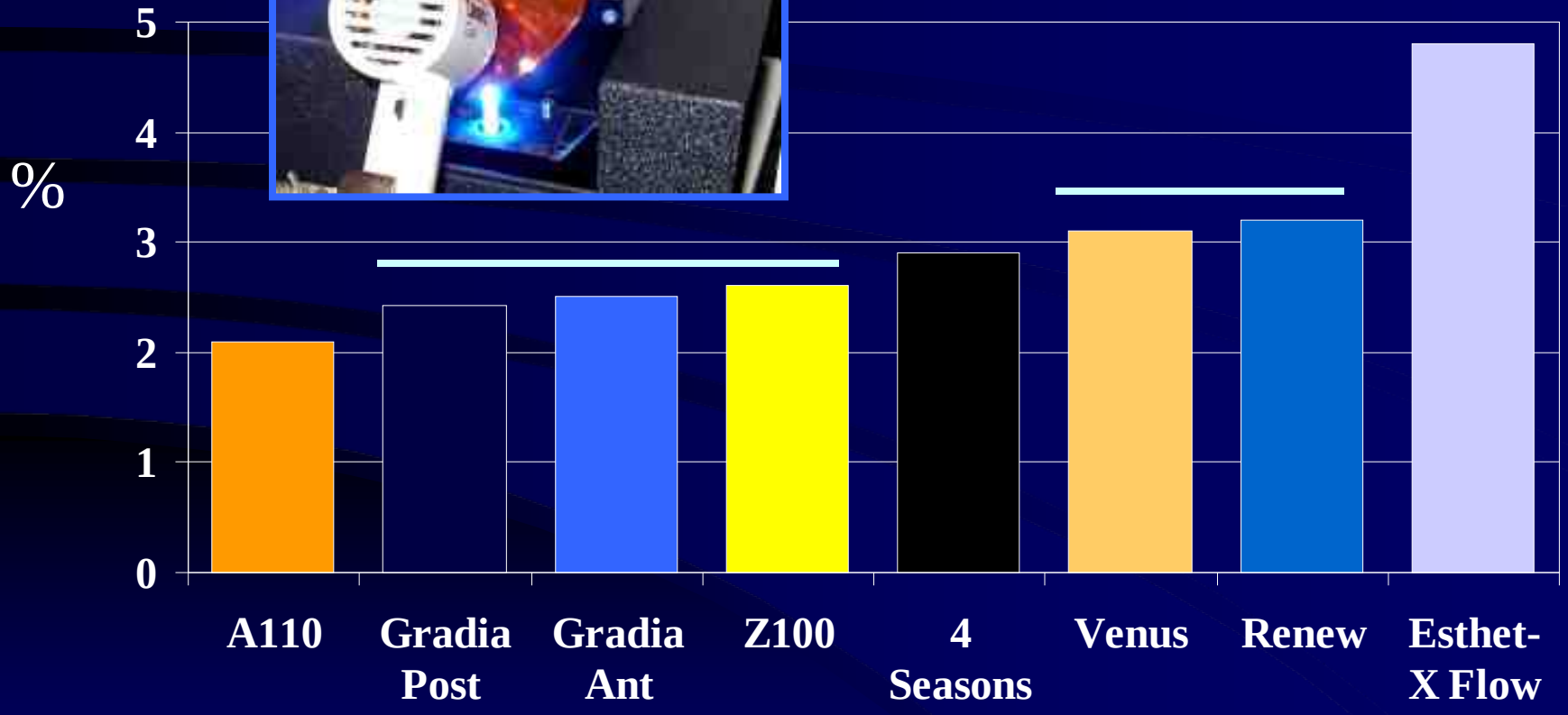
Source: USAF DIS Project 03-037



Horizontal lines connect nonsignificant differences (p<0.05); N=5

Volumetric Shrinkage

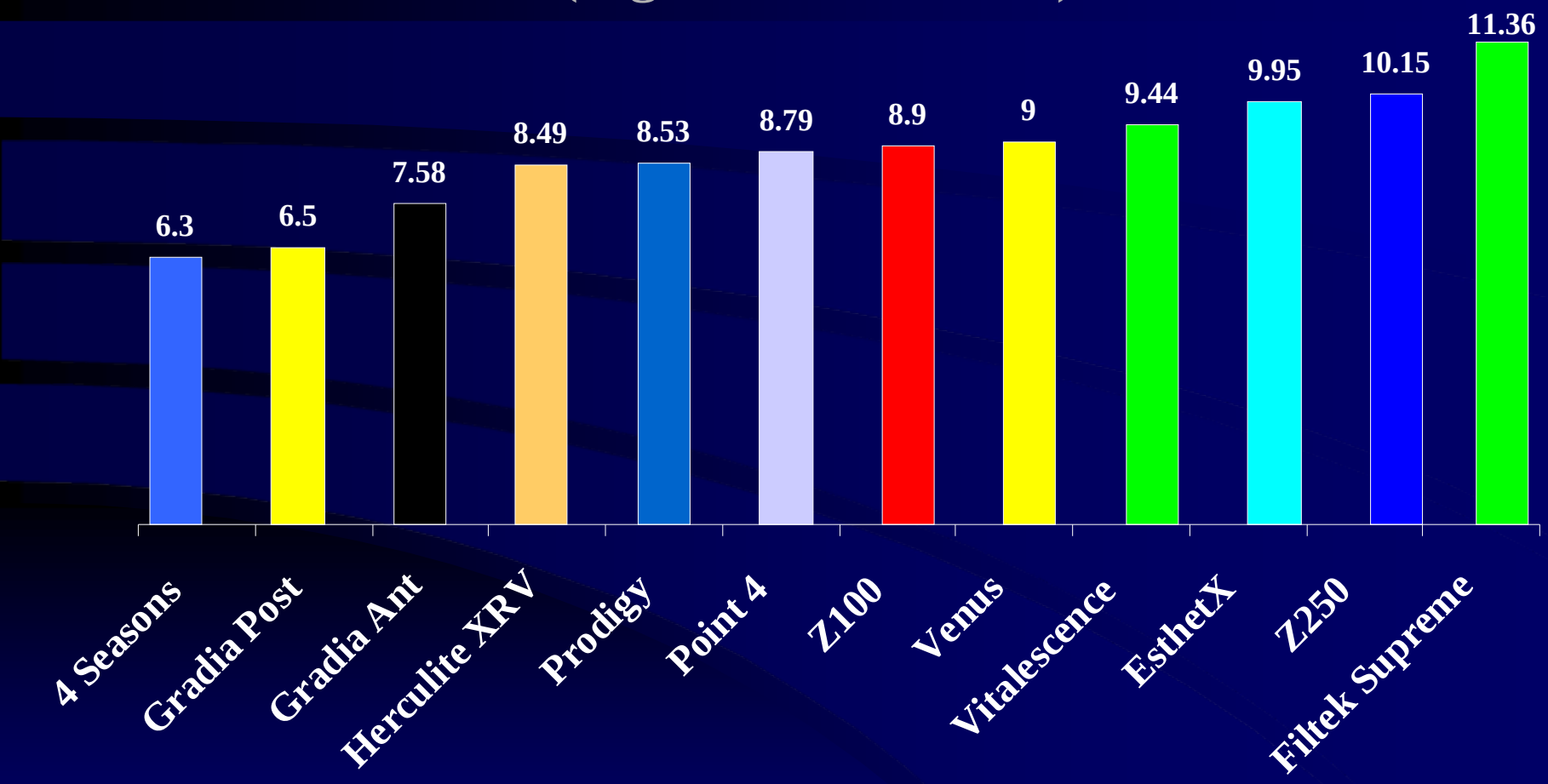
Source: USAF DIS Project 03-027



Horizontal lines connect nonsignificant differences ($p<0.05$); N=5

Government Price

($/gm of refill resin)



Source: USAF DIS; prices current as of 03/03

Recommended by DIS

- Prodigy (Kerr)
  - filler particles
    - average: 0.6 microns
    - filled: 79% wgt
  - inexpensive
  - great handling
  - convenient packaging
    - Optibond
  - 18 shades
    - only 5 in kit
    - capsules