



# CeIFX™ Matrix Technology Super Slim Filter Comparison with Commercial Carbon Filters

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SMOKE SCIENCE AND PRODUCT TECHNOLOGY

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"CeIFX™ technology is not intended for use in cigarettes manufactured for commercial distribution in the United States"

# Outline

- ▶ Objective:
  - Compare CelFX™ Matrix Technology with standard commercial carbon filter designs.
- ▶ CelFX™ Matrix Technology Overview
- ▶ Physical Comparison
- ▶ Carbonyl Results
  - ISO
  - Canadian Intense
- ▶ Conclusions

# CelFX™ Matrix Technology

## *Overview*

- ▶ Multi-year development effort
- ▶ Response to market needs
  - Solution for new and increasing regulations
  - Brand innovation
  - High performance filtration
- ▶ Commercial cigarette filter developed by Celanese
- ▶ Focused on preserving the smoking experience while harnessing Celanese broad filtration knowledge



# CelFX™ Matrix Technology

## *Overview*

- ▶ Uses proprietary binder technology /manufacturing process:
  - High active ingredient loadings (activated carbon)
  - Control pressure drop to target (low or high)
  - Lower dust products, despite much higher loadings
- ▶ Expands filter design beyond traditional boundaries
  - Example: Carbon loading in super-slim > 5.5 mg/mm with EPD of 2.0 mm/mm (less than possible with tow only)

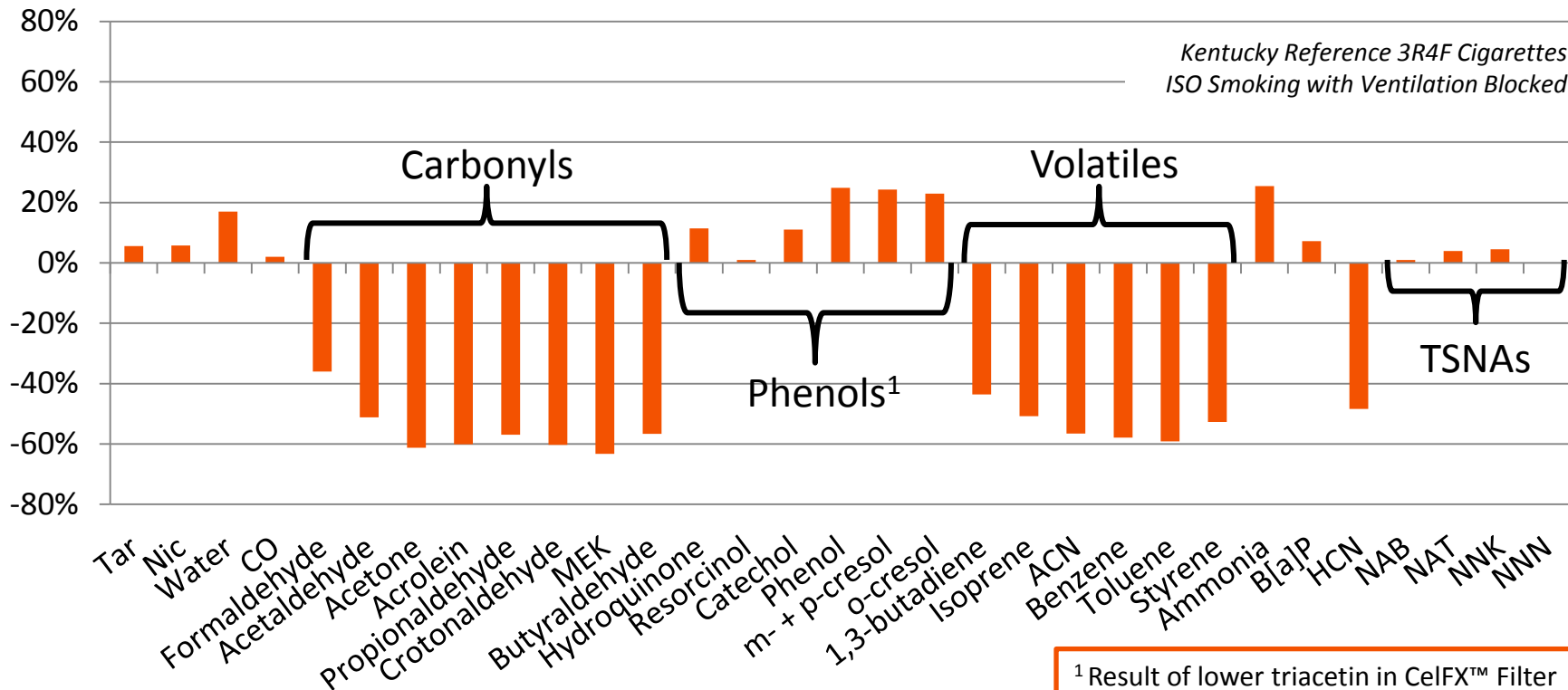


# Overview

## Smoke Filtration Performance

## % Change with 12 mm CelFX vs Carbon-on-tow Control

Hand-made versus hand-made



Significant improvement in removal efficiency of gas-phase components vs. carbon-on-tow  
(40-60% improvement)

# CelFX™ Matrix Technology

## Ingredients



Carbon



Paper



Seam Glue



Binder

*All ingredients meet  
German Tobacco  
Ordinance Requirements*



Carbon Rods

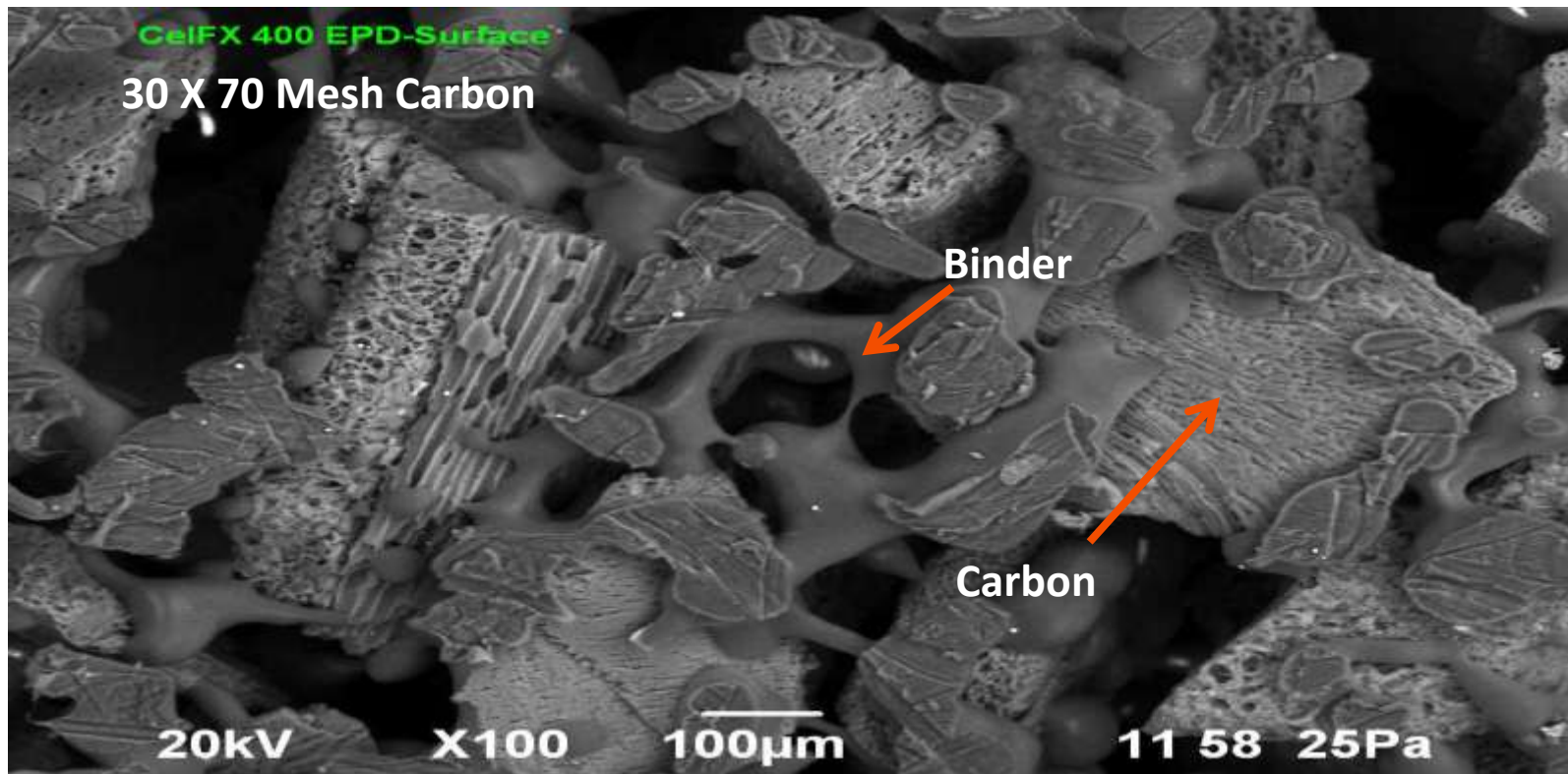


Acetate Rods



Combined Rods

# Inside Look



# Experimental Design

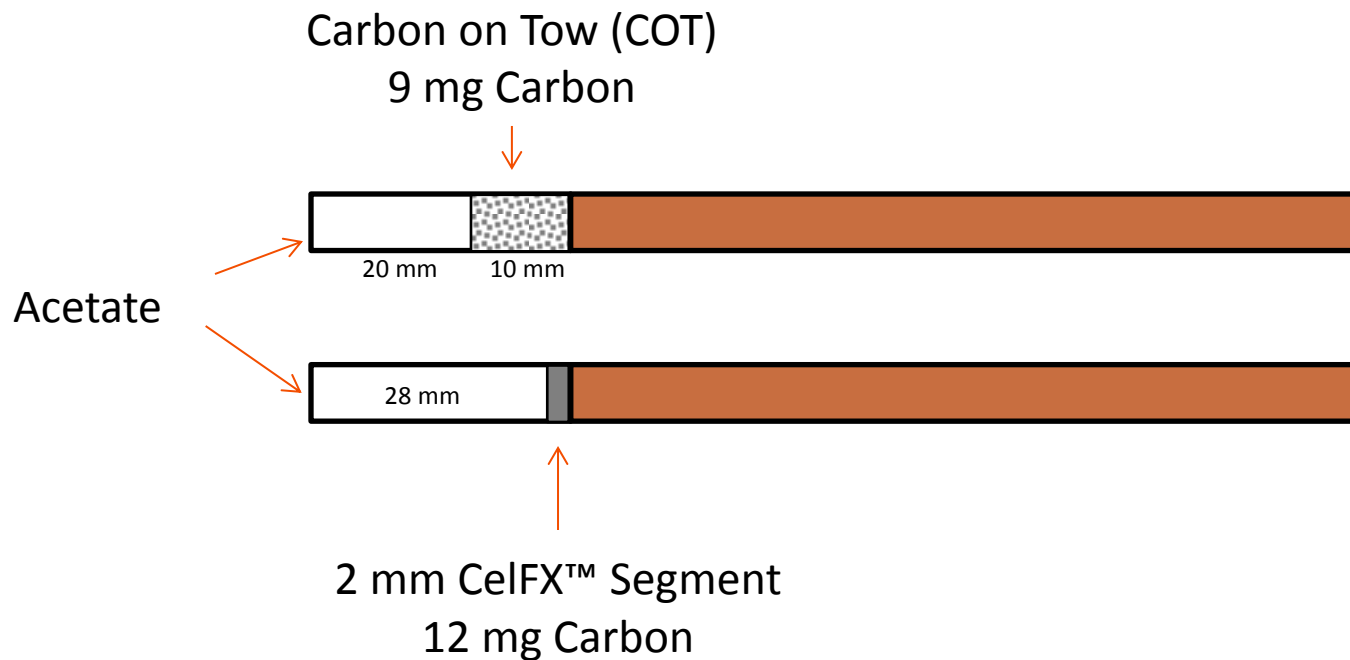
- ▶ Machine made super-slim filters (cavity and carbon-on-tow)
- ▶ Tobacco column from commercial super-slim cigarette
- ▶ Hand Assembled Cigarettes
  - Matched total pressure drops
- ▶ Carbonyl Analysis
  - CRM 74
  - ISO 3308 - vent holes blocked
  - Canadian Intense



# Super Slim Filter Rod Physical

	PD (mm of water /mm of length)	Carbon loading (mg/mm)	Carbon Loading (per tip)
10 mm, Carbon on tow	7.8	0.9	9.0 mg
15 mm, Carbon on tow	5.0	0.5	7.6 mg
6 mm Cavity, + 24 mm Acetate	6.0	9.0	54.0 mg
2 mm CelFX™	3.8	6.0	12.0 mg
5 mm CelFX™	3.8	6.0	30.0 mg
10 mm CelFX™	3.8	6.0	60.0 mg
15 mm CelFX™	3.8	6.0	90.0 mg

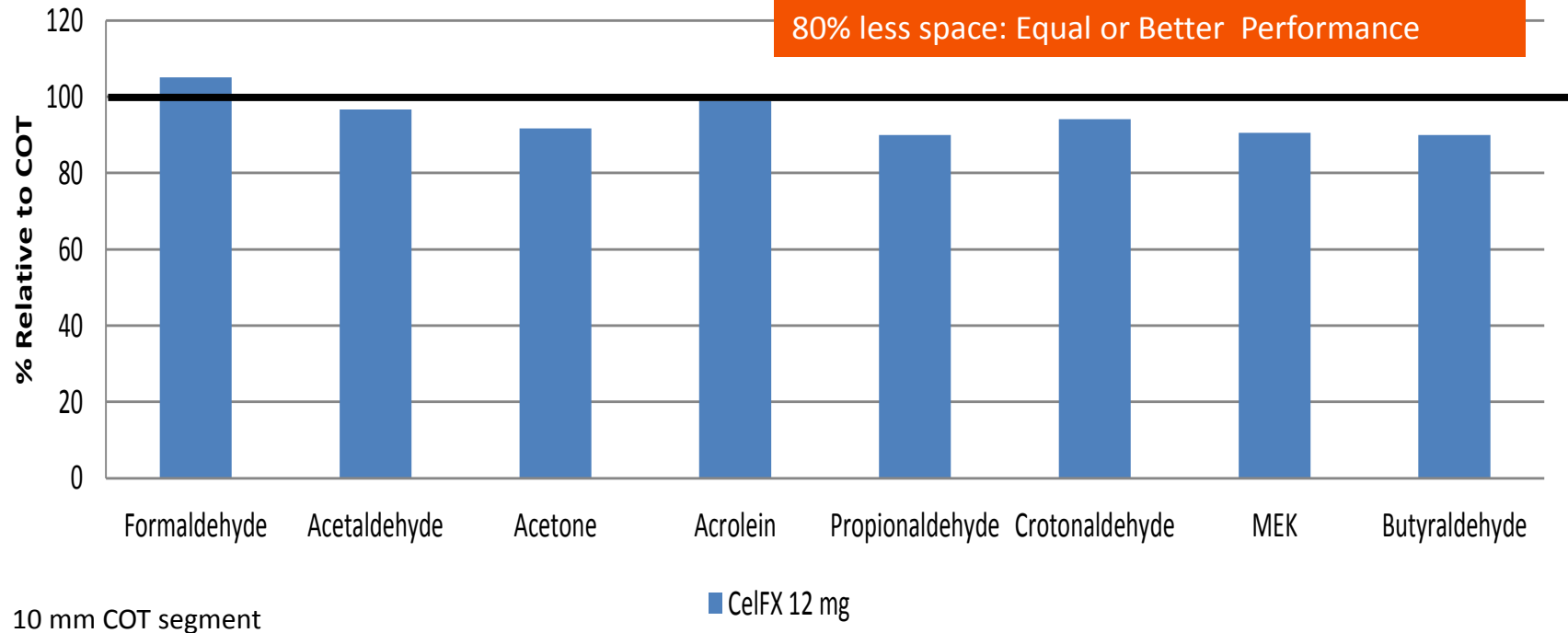
## Similar Loading: Hand Assembled Cigarettes



Filter length = 30 mm

# Similar Loadings

## ISO: 2 mm CelFX Relative to COT Filter Rod, Matched Loading



# COT, Cavity compared with various CelFX™ segment lengths: Hand Assembled Cigarettes

## Carbon Loadings

### Conventional Filter Rods

COT: 7.6 mg



Cavity: 54 mg



### CelFX™, Various Lengths

5mm, 30 mg



10 mm, 60 mg

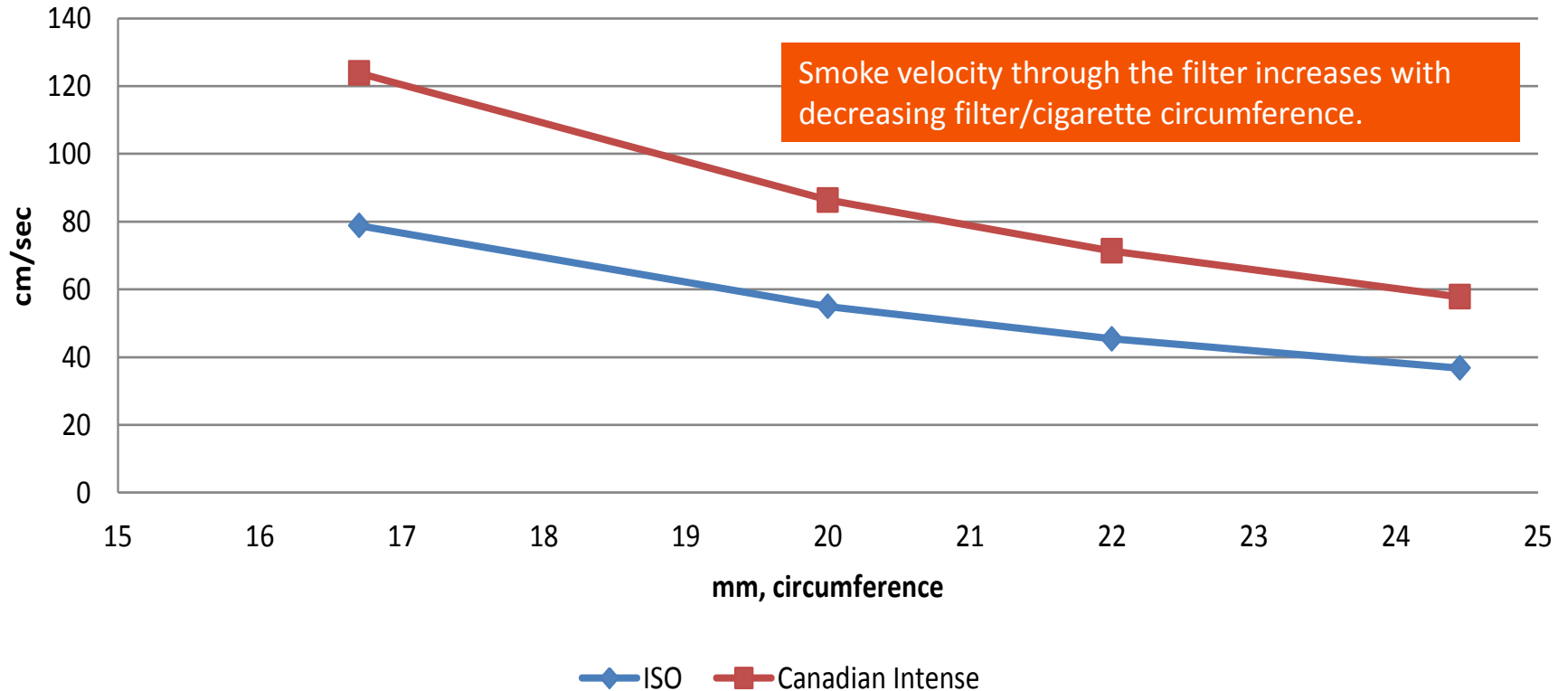


15 mm, 90 mg

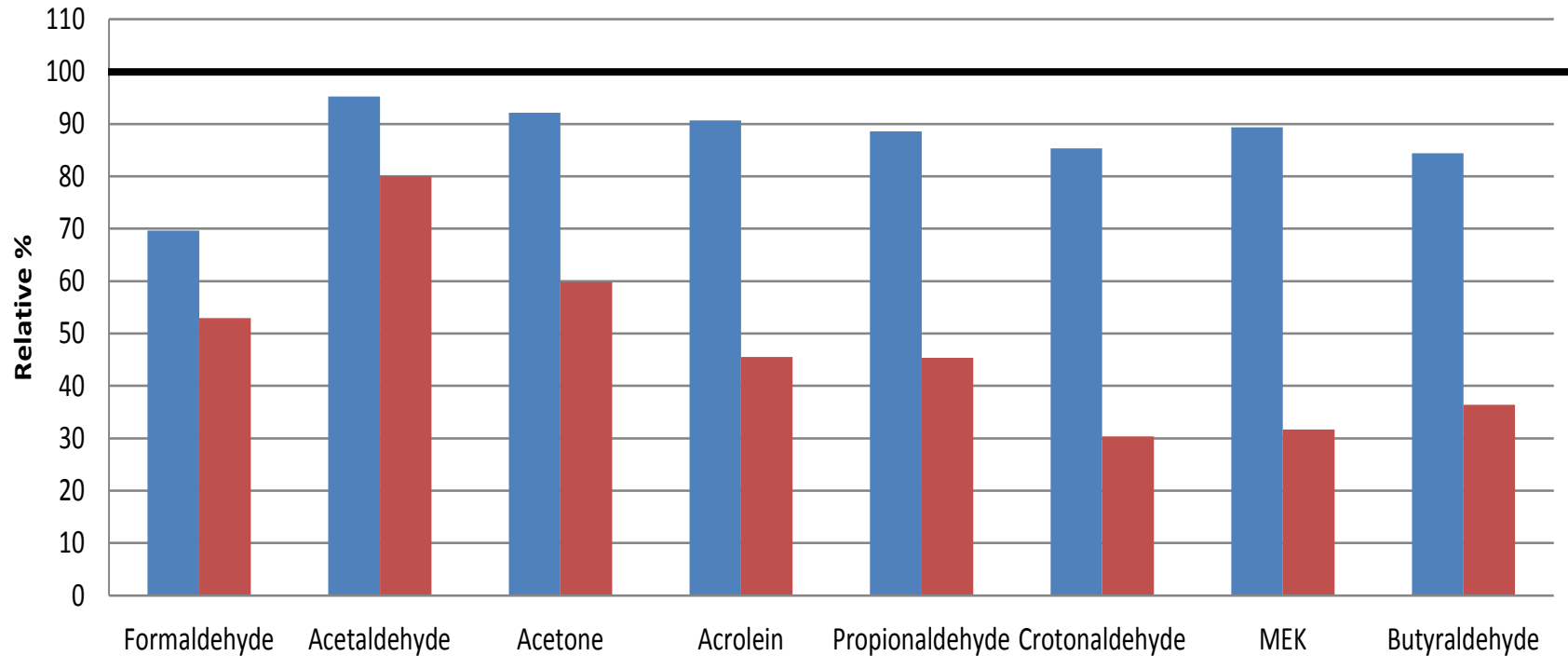


Filter length = 30 mm

## Smoke Velocity ISO and Canadian Intense



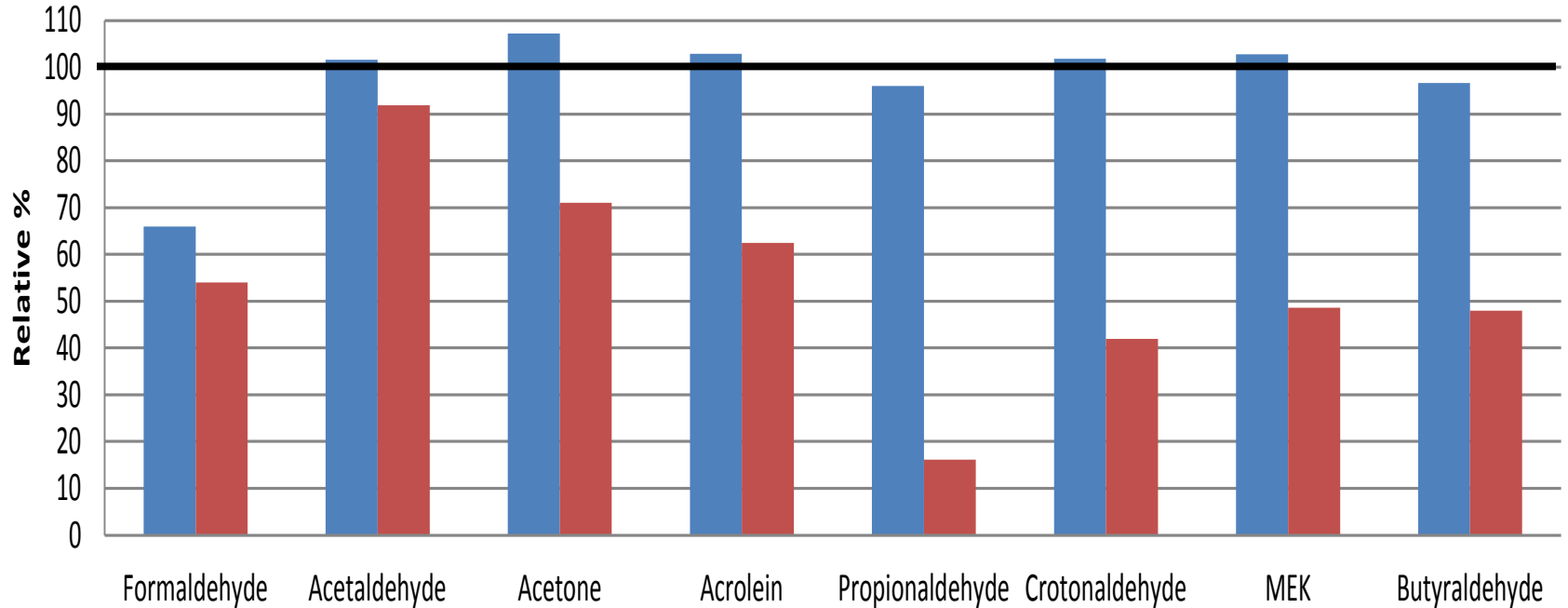
## ISO: Carbon on tow, Cavity Relative to Control



Benchmarking: Commercial carbon filters reduce carbonyls using the ISO 3308 smoking protocol

■ COT 7.6 mg ■ Cavity 54 mg

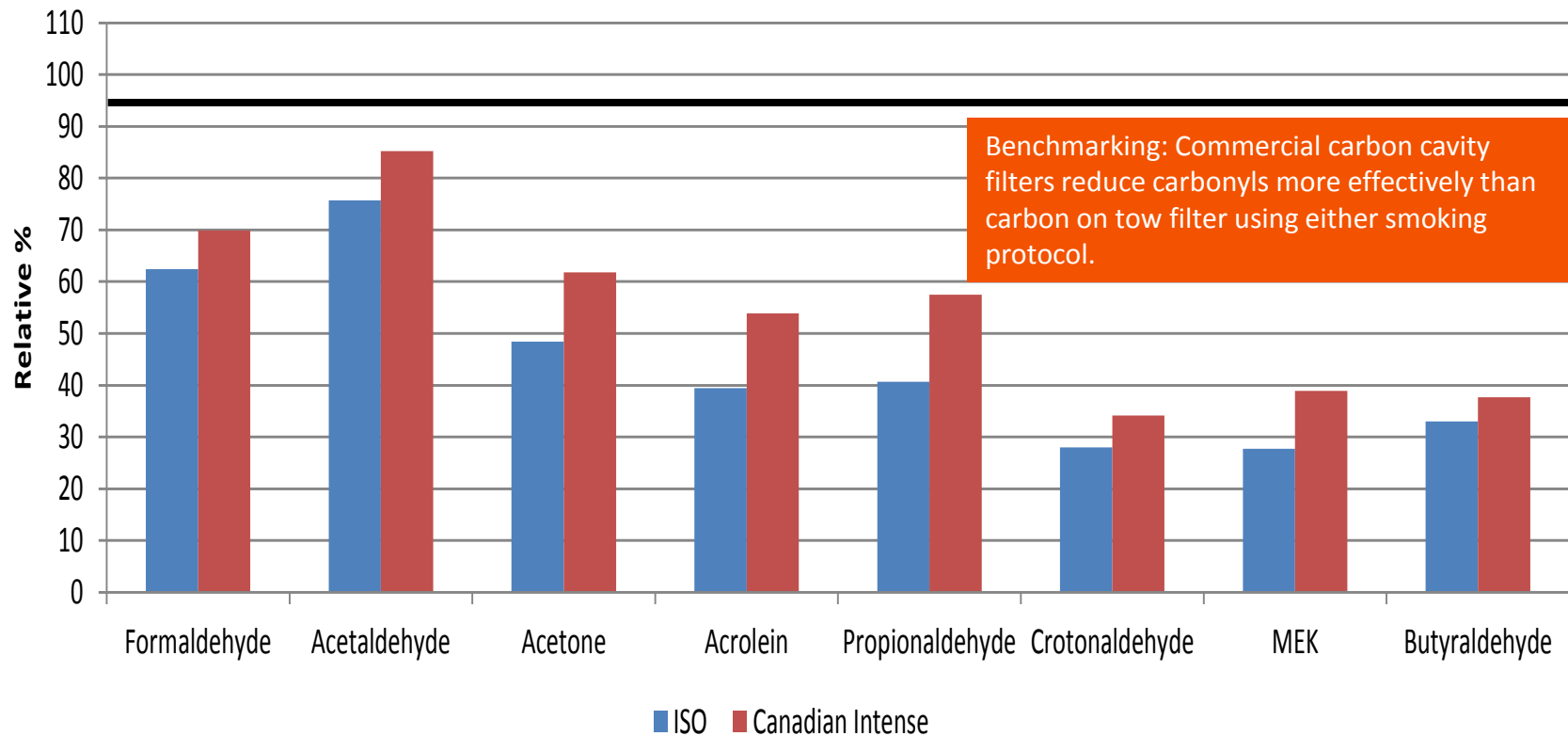
## Canadian Intense: Carbon on Tow, Cavity Relative to Control



Benchmarking: Carbon on tow filter do not reduce carbonyls effectively when smoked using the Canada Intense smoking protocol but cavity filters do.

■ COT 7.5 mg ■ Cavity 54 mg

## ISO and Canadian Intense: Cavity Relative to Carbon on Tow

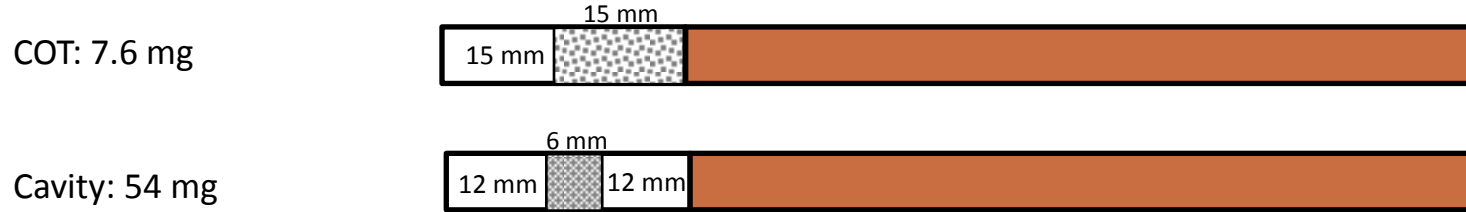




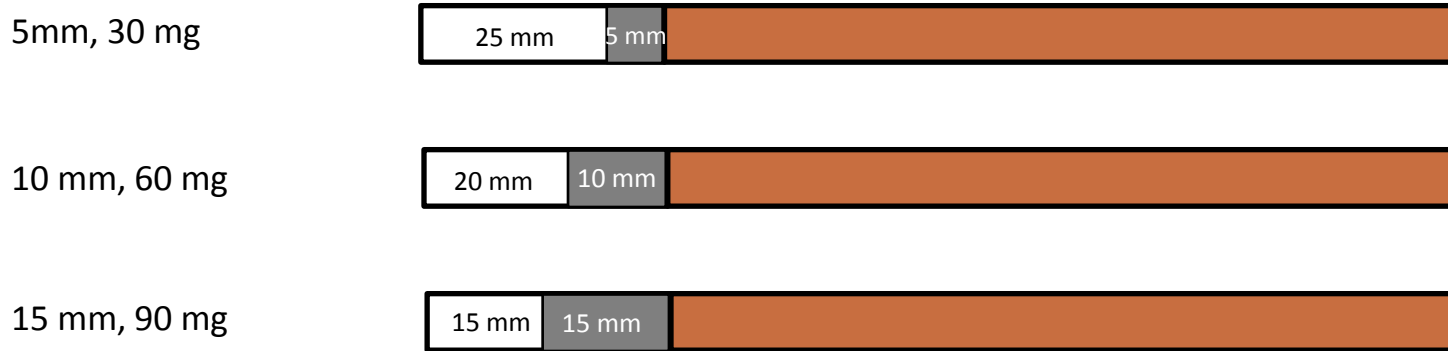
# COT, Cavity compared with various CelFX™ segment lengths: Hand Assembled Cigarettes

## Carbon Loadings

### Conventional Filter Rods

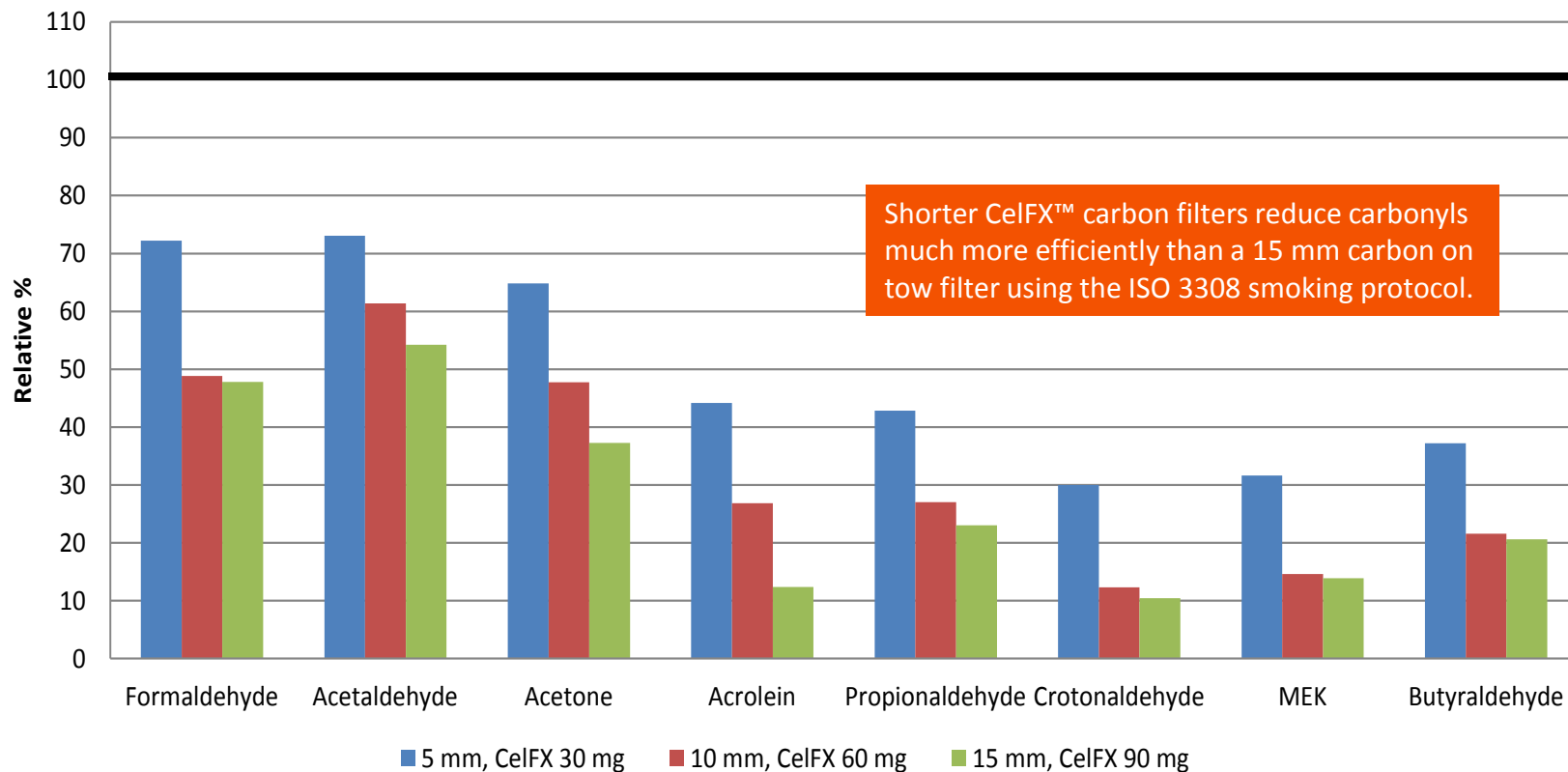


### CelFX™, Various Lengths

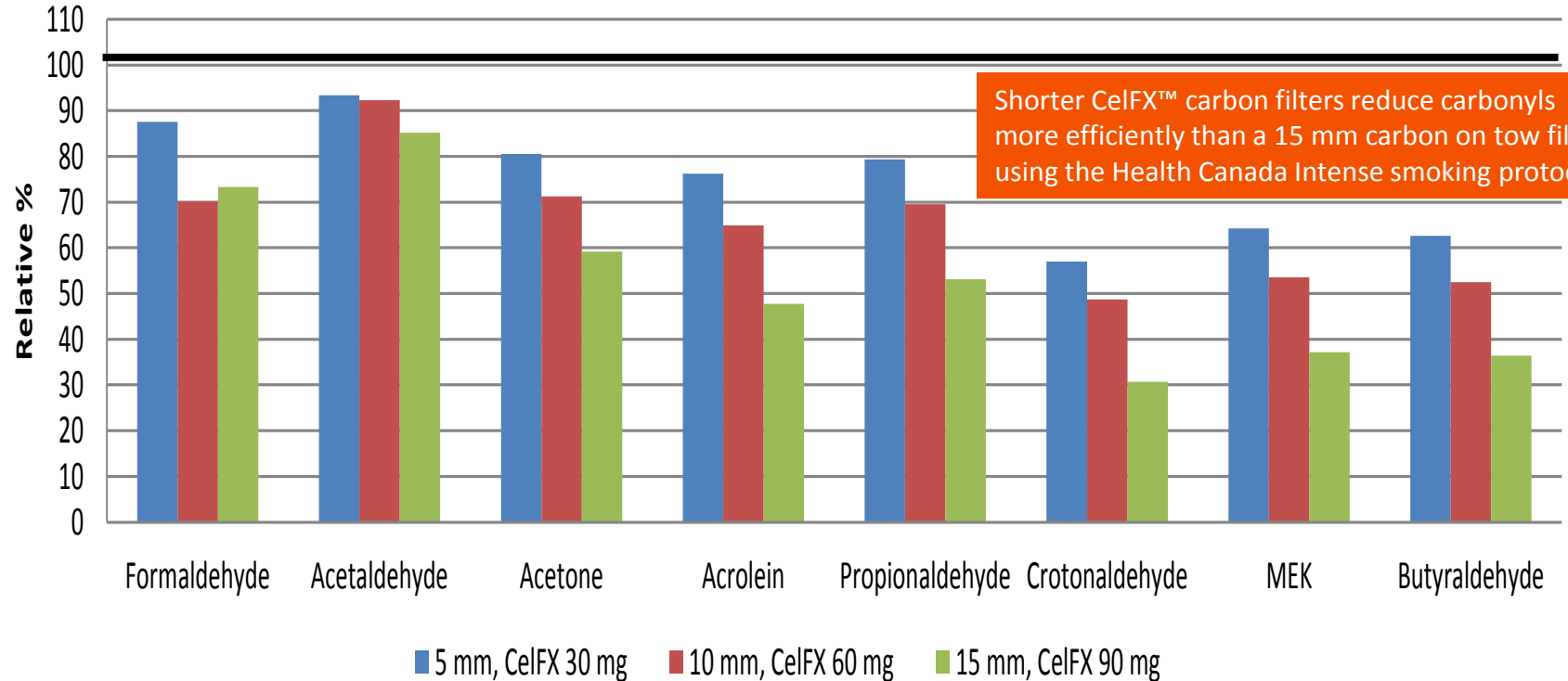


Filter length = 30 mm

## ISO: CelFX™ Relative to Carbon on Tow

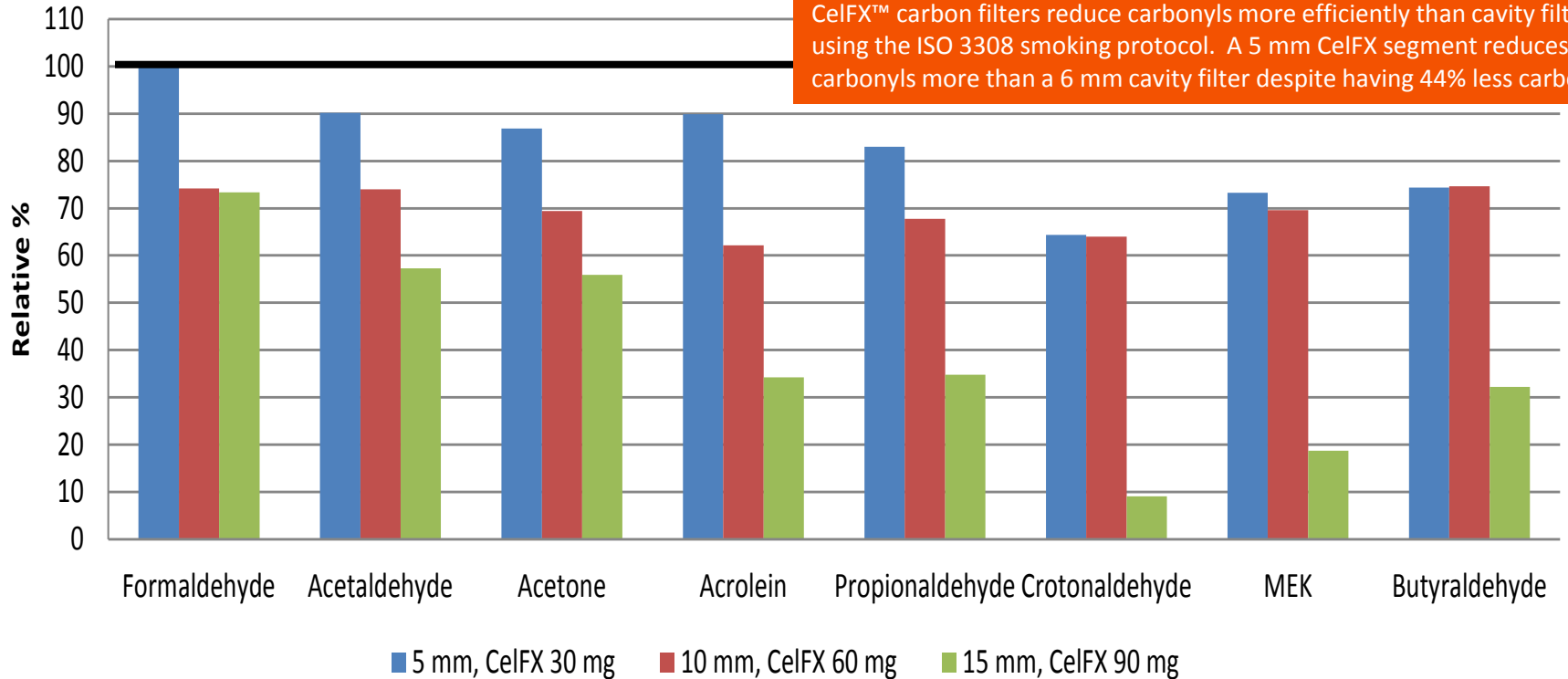


# Canadian Intense: CelFX™ Relative to Carbon on Tow

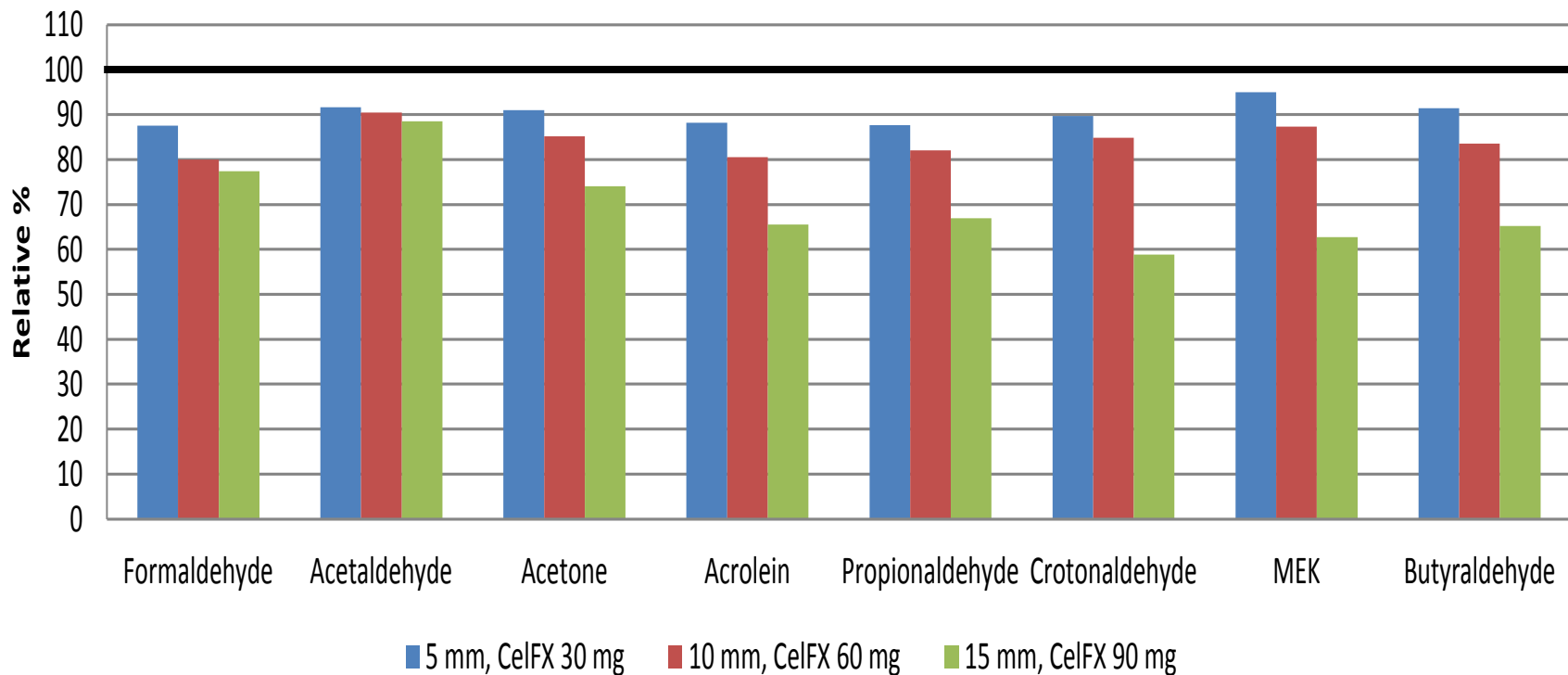


# ISO: CelFX™ Relative to Cavity Control

CelFX™ carbon filters reduce carbonyls more efficiently than cavity filters using the ISO 3308 smoking protocol. A 5 mm CelFX segment reduces carbonyls more than a 6 mm cavity filter despite having 44% less carbon.



# Candian Intense: CelFX™ Relative to Cavity



CelFX™ carbon filters reduce carbonyls more efficiently than cavity filter using the Health Canada Intense smoking protocol. A 5 mm CelFX segment reduces carbonyls more than a 6 mm cavity filter despite having 44% less carbon.

# Conclusions: ISO Smoking

- ▶ CelFX™ filters achieves greater constituent reduction with similar loadings of conventional cavity and carbon-on-tow designs
- ▶ CelFX™ filters can achieve greater constituent reduction with less space and less carbon than conventional carbon filters
  - Improved reduction vs. carbon-on-tow with 80% less filter length
  - Improved reduction vs. cavity with 20% less length and 44% less carbon
- ▶ Demonstrates improved smoke contact
- ▶ Higher carbon loadings = higher reductions

# Conclusions: Canadian Intense

- ▶ Smoke velocity, filter residence time impacts reduction
- ▶ Carbon-on-tow has little to no impact
  - Short filter resident time
  - Low carbon loading
- ▶ Cavity
  - Improved reductions
  - Higher carbon loadings
- ▶ CelFX™ Filters
  - More efficient smoke contact
  - Achieved better constituent reduction than cavity filters with 44% less carbon
    - Very low dust vs. cavity filter
    - Filter designed to eliminate bypass
  - Higher carbon loadings = high reductions

# Thanks

- ▶ Dr. Sayanti Basu
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