EC/OC Workshop

Measuring Elemental Carbon Absorption Using a Dual Thermal Optical Reflectance/Transmittance Analyze**Challenges in EC/OC studies**

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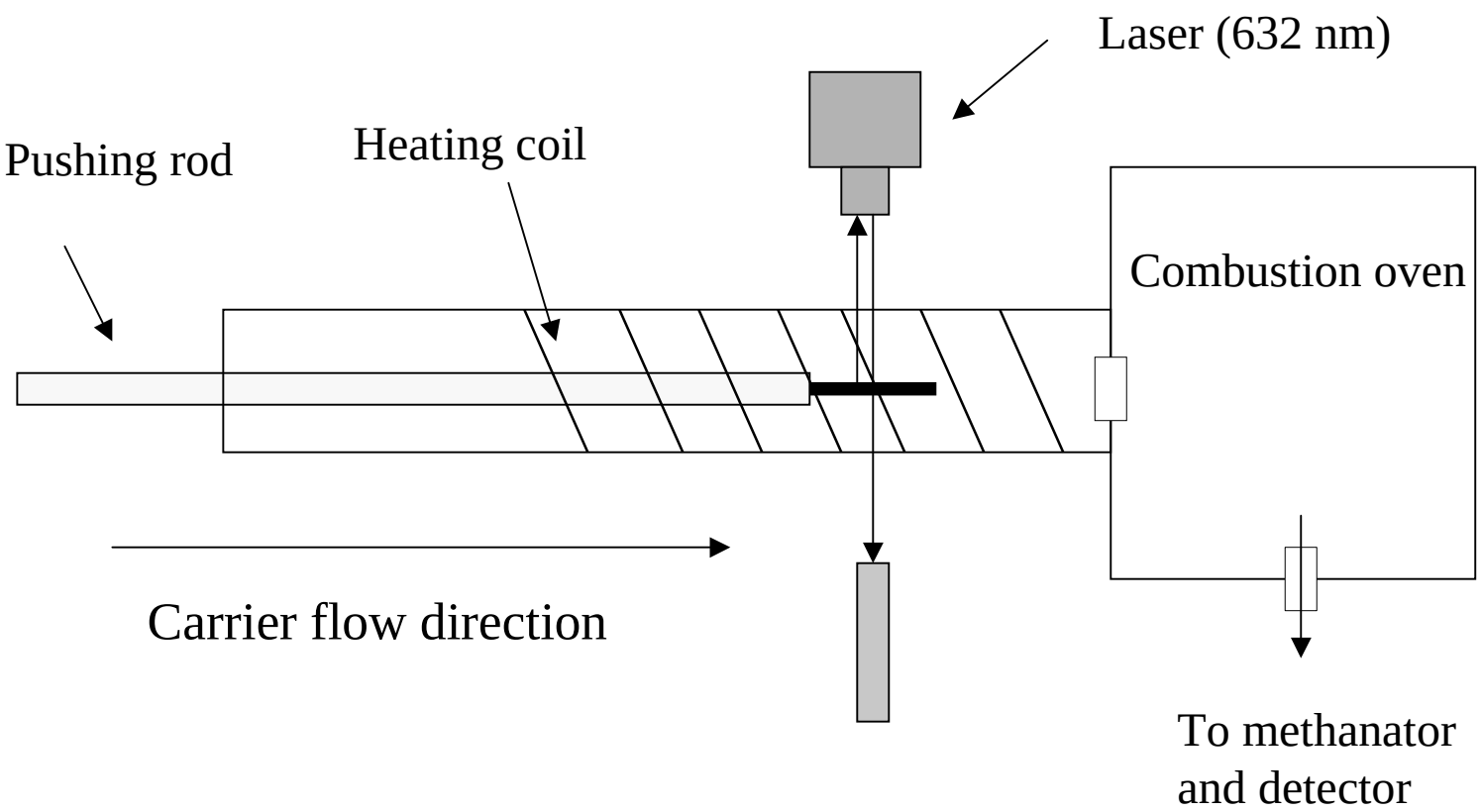
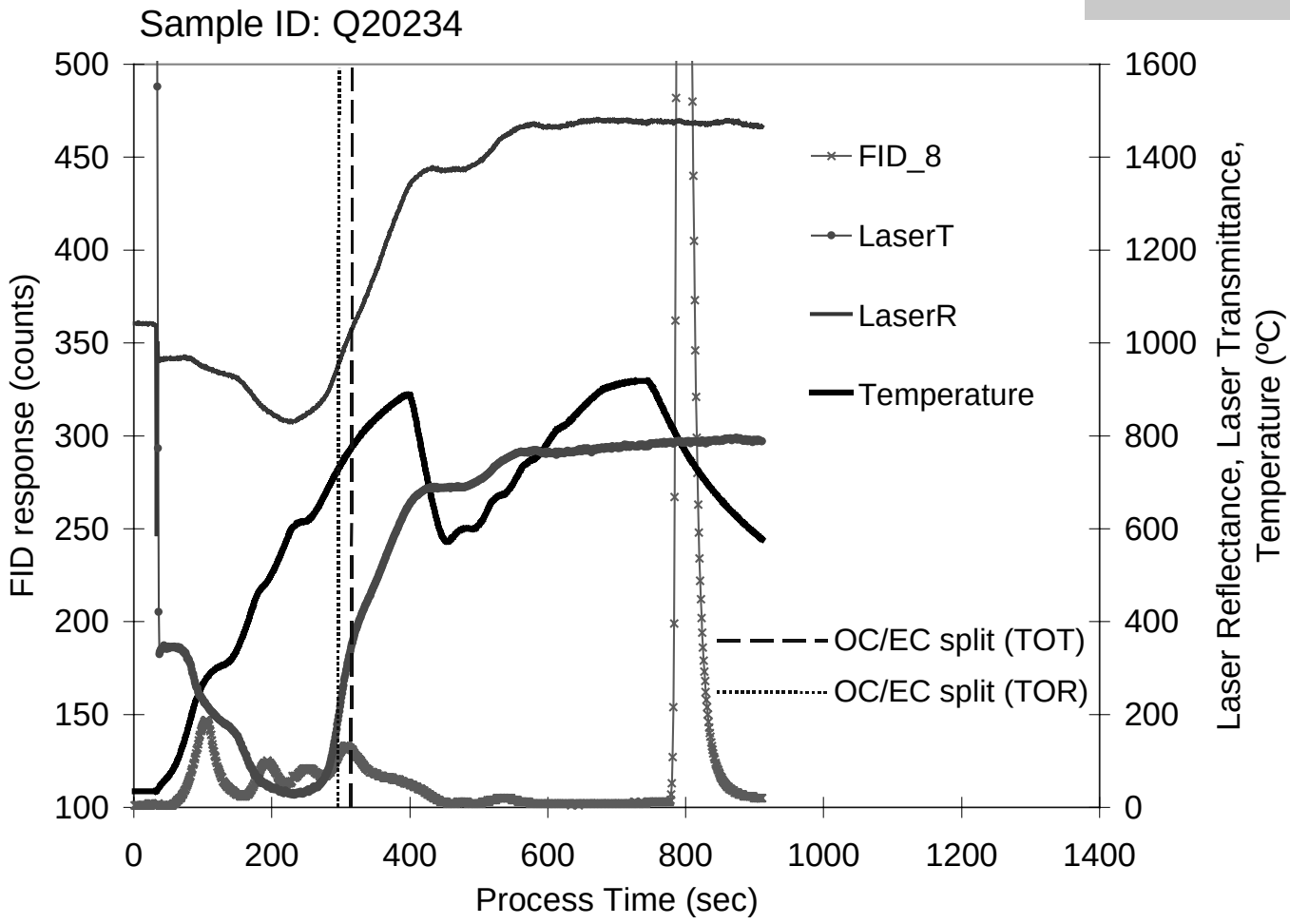
Review of Thermal/Optical Method

1. Liberating carbon compounds from sample punches taken from a exposed filter (usually quartz) under different temperature and oxidation environment.
2. Converting carbon to carbon dioxide (CO_2) or methane (CH_4) and then quantifying it.
3. Monitoring filter reflectance or transmittance via a laser at a specific wavelength. Determine the OC/EC split point as where the laser signal returns to its initial value.

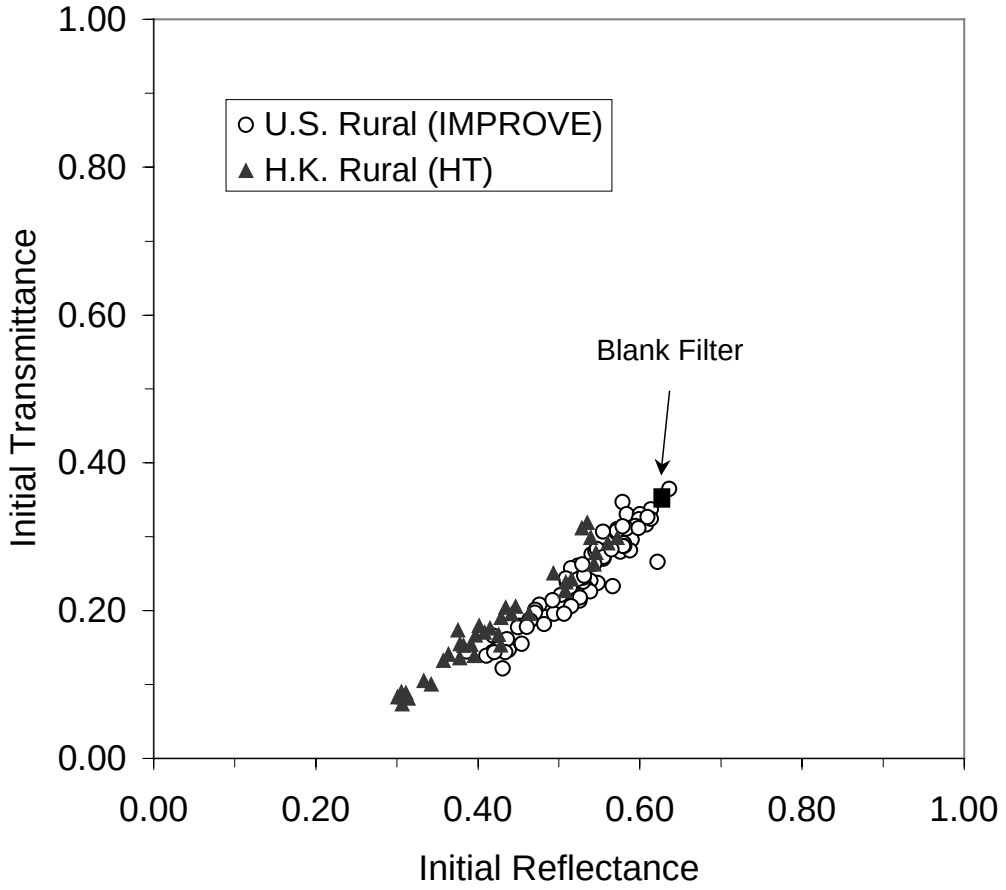
Dual Thermal Reflectance/Transmittance Analyzer



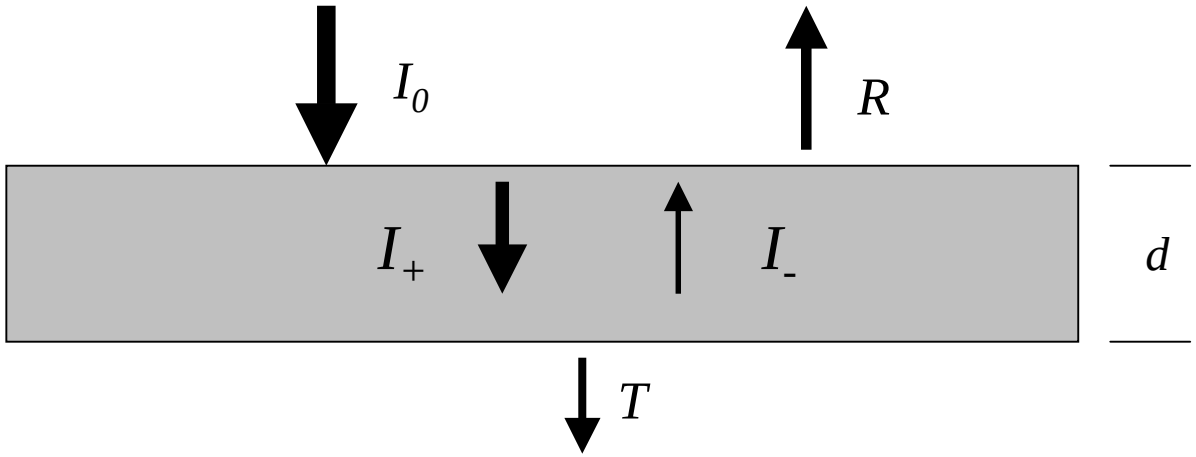
Typical Thermogram



Compare Initial Reflectance and Transmittance



One Uniform Layer Model



$$\frac{dI_+}{dz} = -\sigma_a I_+ - \beta\sigma_s I_+ + \beta\sigma_s I_-$$

$$\frac{dI_-}{dz} = \sigma_a I_- + \beta\sigma_s I_- - \beta\sigma_s I_+$$

σ_a: Absorption cross section

σ_s: Scattering cross section

β: back scatter fraction

One Uniform Layer Model (Cont.)

$$R = \frac{\beta\sigma_s(1-e^{-2pd})}{(p-\sigma_a-\beta\sigma_s)e^{-2pd}+(p+\sigma_a+\beta\sigma_s)}$$

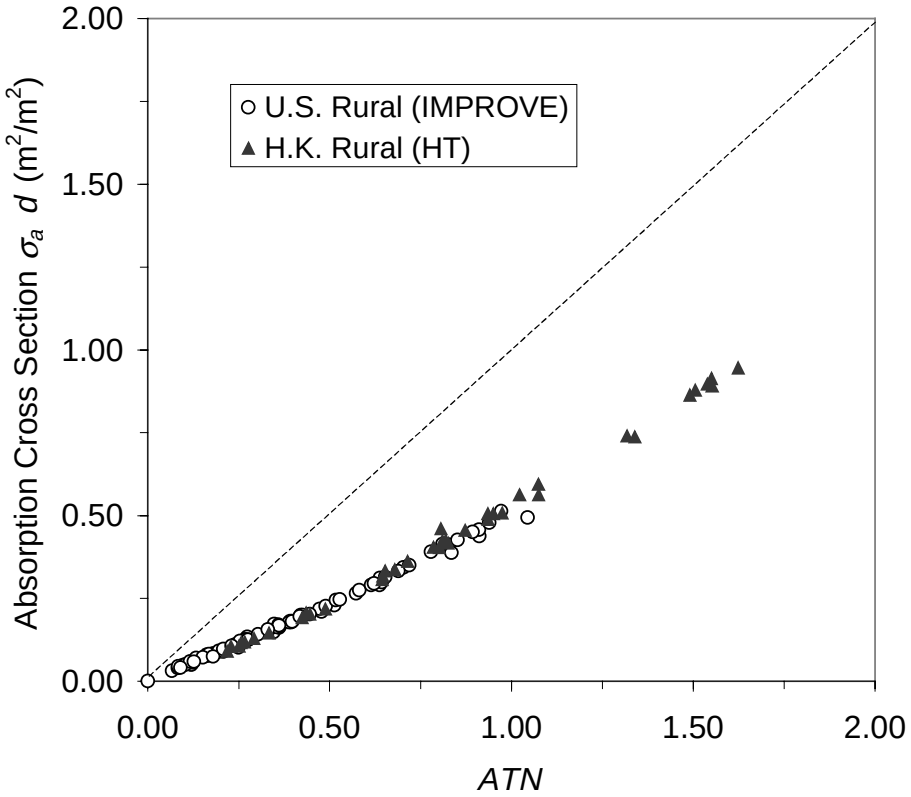
$$T = \frac{2pe^{-pd}}{(p-\sigma_a-\beta\sigma_s)e^{-2pd}+(p+\sigma_a+\beta\sigma_s)}$$

$$p = \sqrt{\sigma_a(\sigma_a+2\beta\sigma_s)}$$

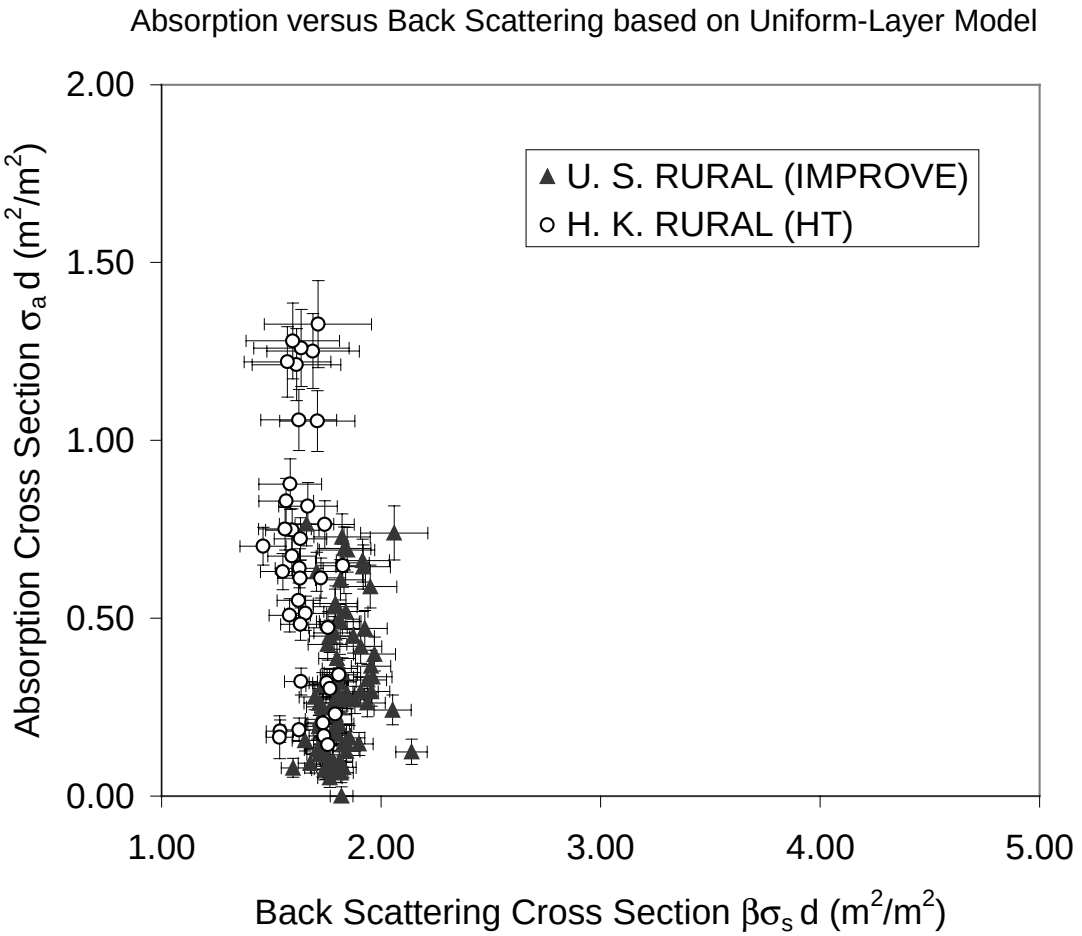
Not the best, but the simplest….

Compare σ_a with $-ln(I/I_0)$

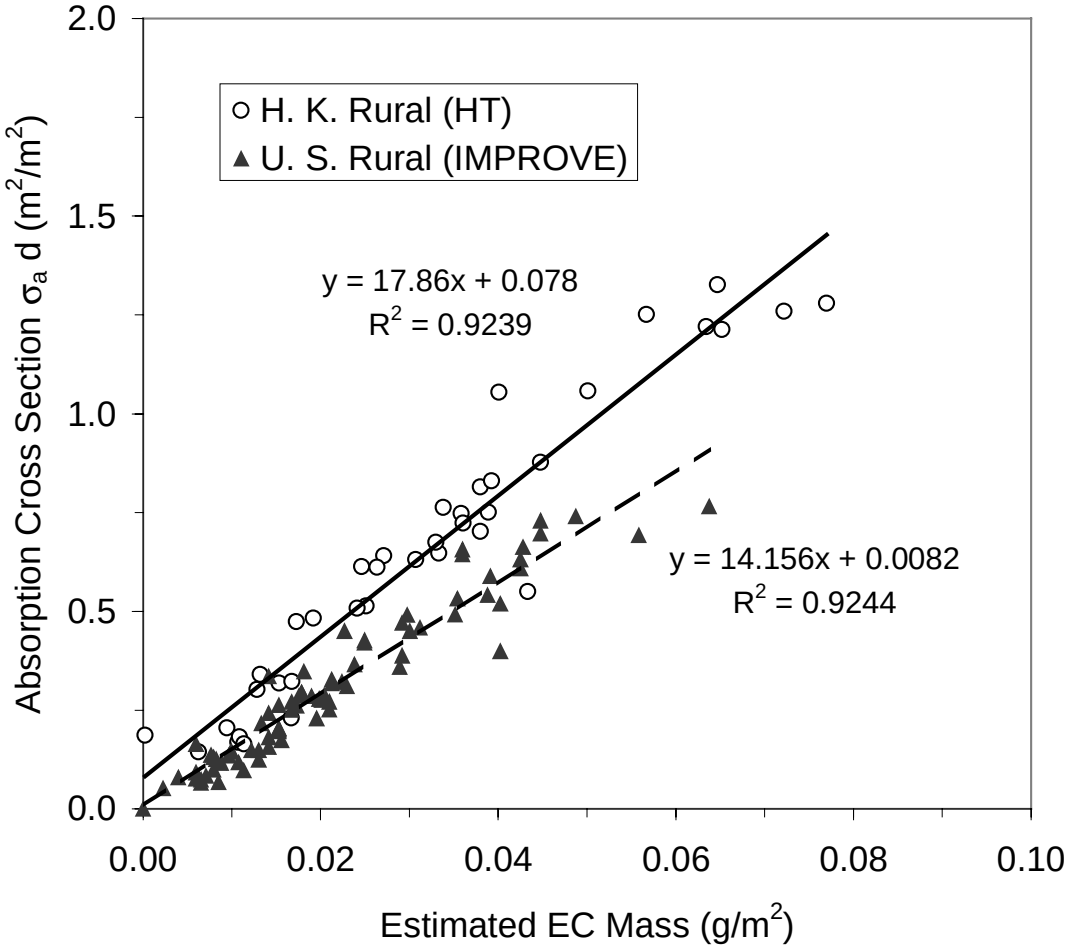
$-ln(I/I_0) = ATN$ = *light attenuation*



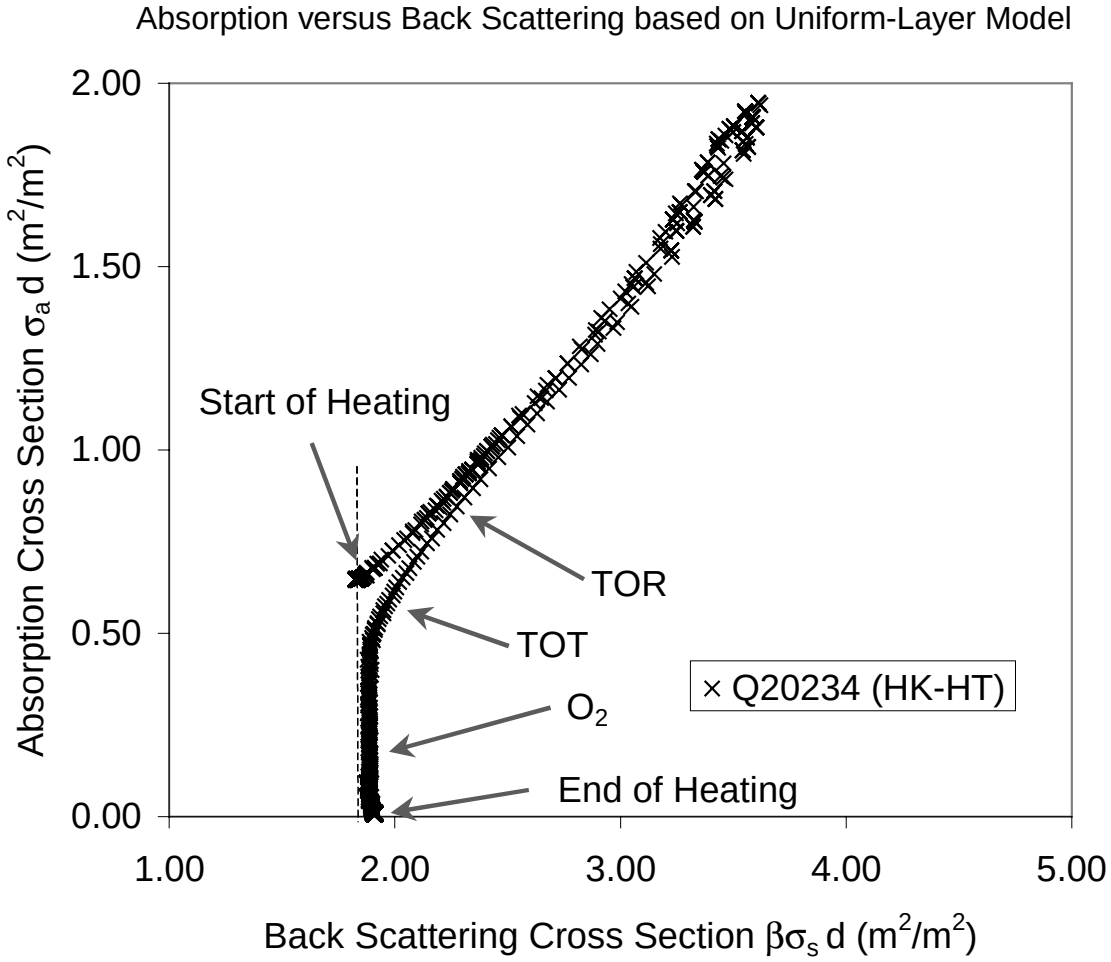
Compare σ_a with $\beta\sigma_s$



Compare σ_a with EC

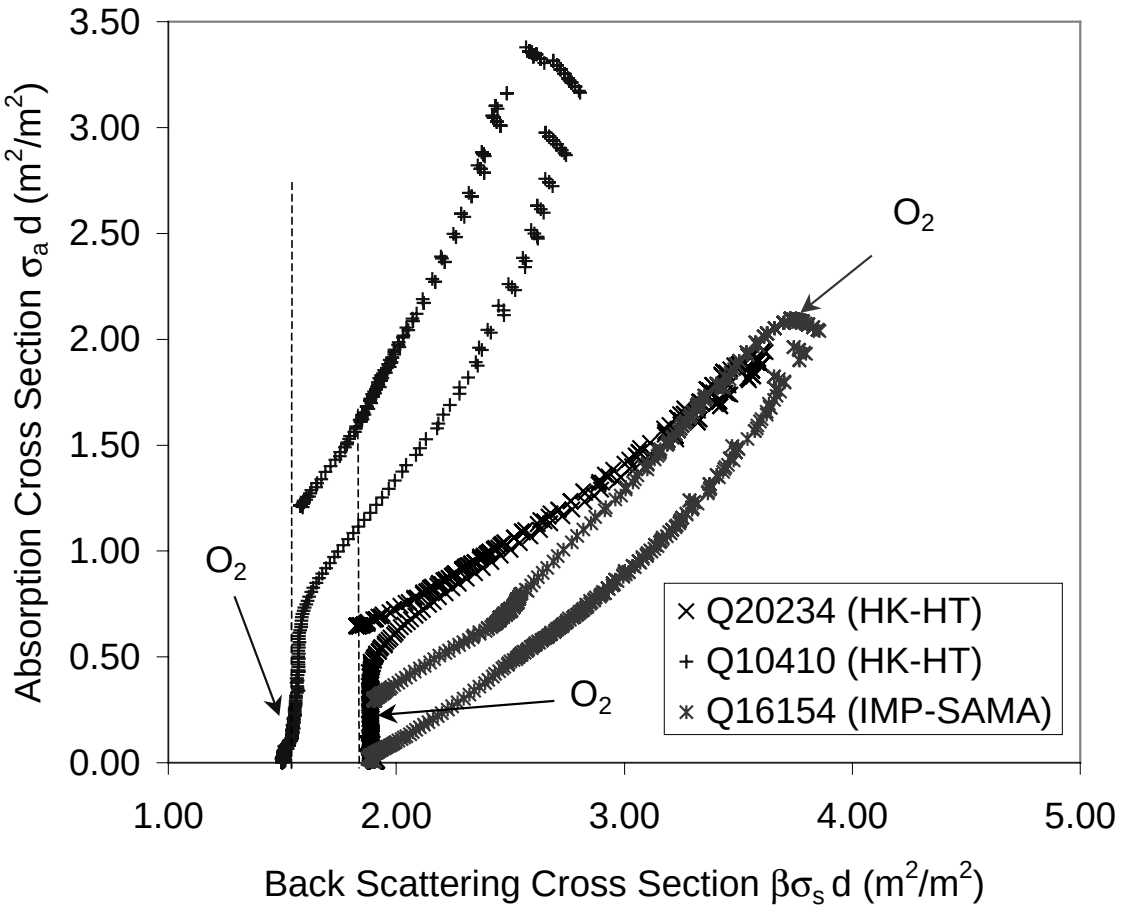


Start the Heating!!

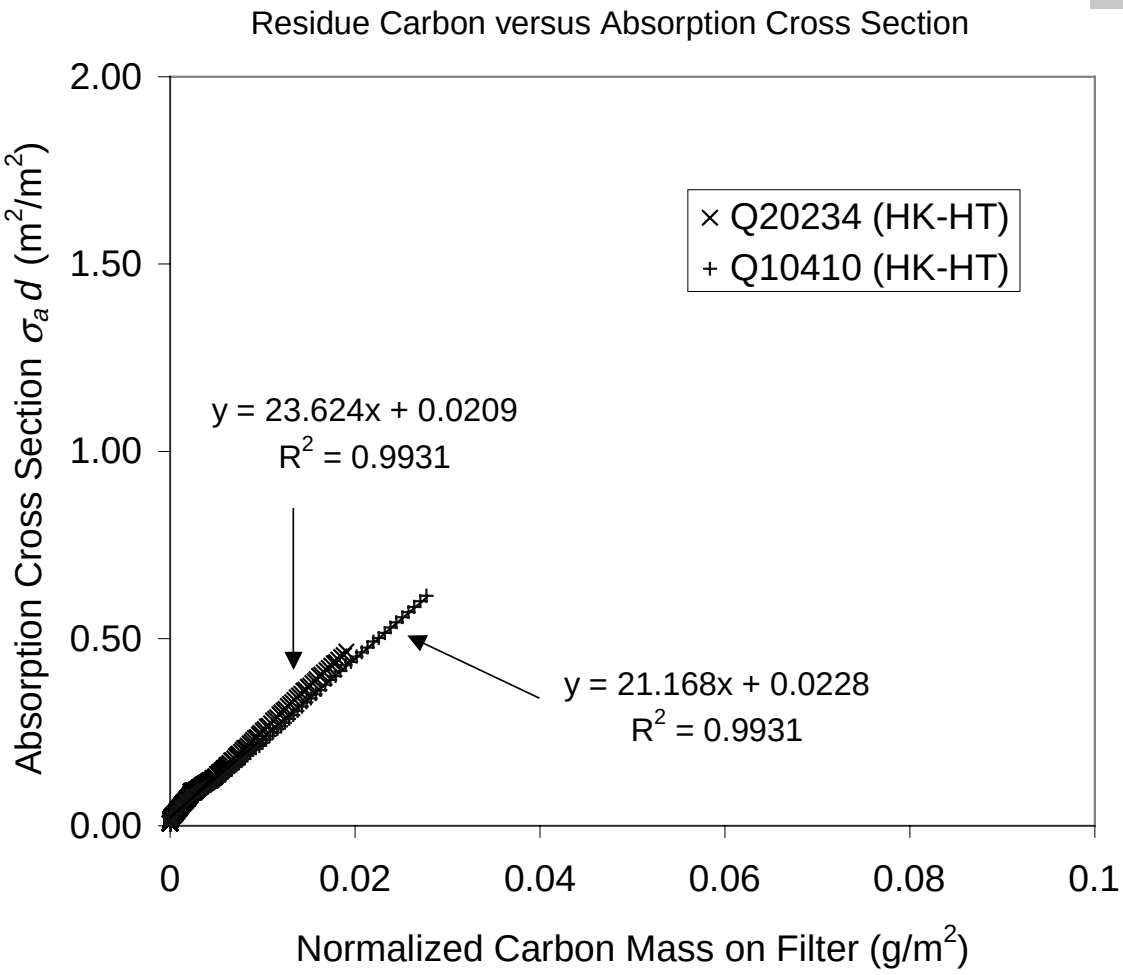


More Examples

Absorption versus Back Scattering based on Uniform-Layer Model



Compare σ_a With Evolved Carbon During Heating



Summary

- Dual thermal reflectance/transmittance carbon analyzer was used and preliminary data were presented.
- Initial filter reflectance and transmittance are tightly correlated to each other, suggesting that they are controlled by a single dominate factor, likely absorption cross section .
- Pyrolyzed carbon produced during heating in the oxygen free environment likely changes the scattering albedo of the filter, leading to different TOT and TOR results.
- Combustion of native EC occurs at the end of thermal analysis, and a relatively higher absorption efficiency is observed.