Impact of Rail Pressure on Soot Morphology and Nanostructure

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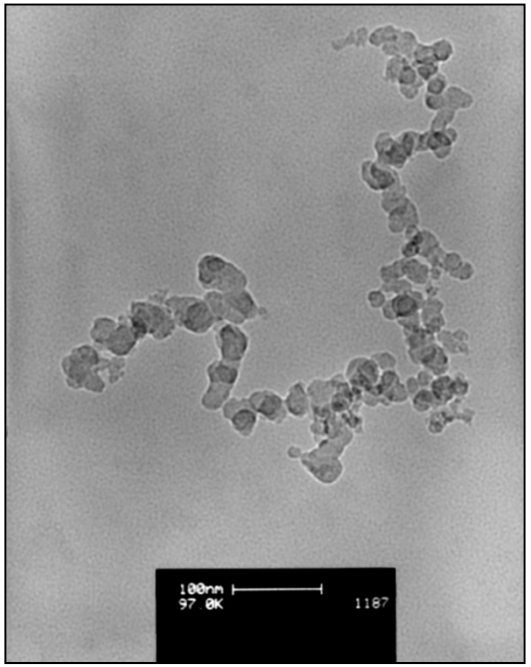
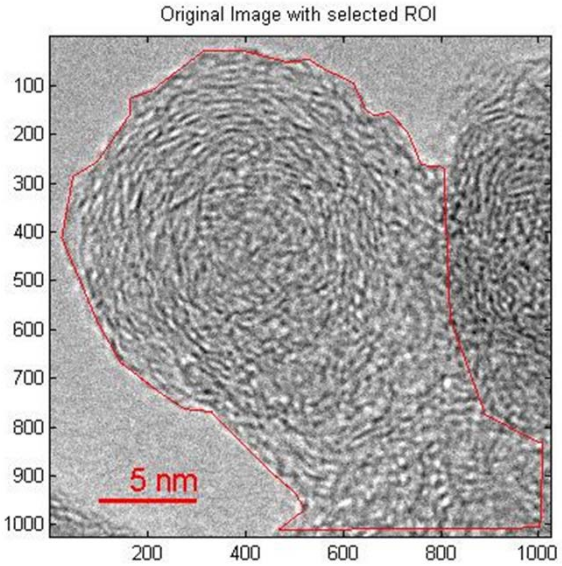
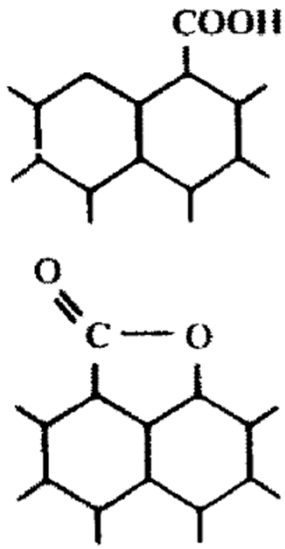
Introduction

- Soot reactivity is critical for DPF regeneration and can be related to
  - Morphology (Lapuerta et al., 2006)
  - Nanostructure (Vander Wal and Tomasek, 2003)
  - Chemical surface compound (Boehm, 1994)







Impact of engine conditions

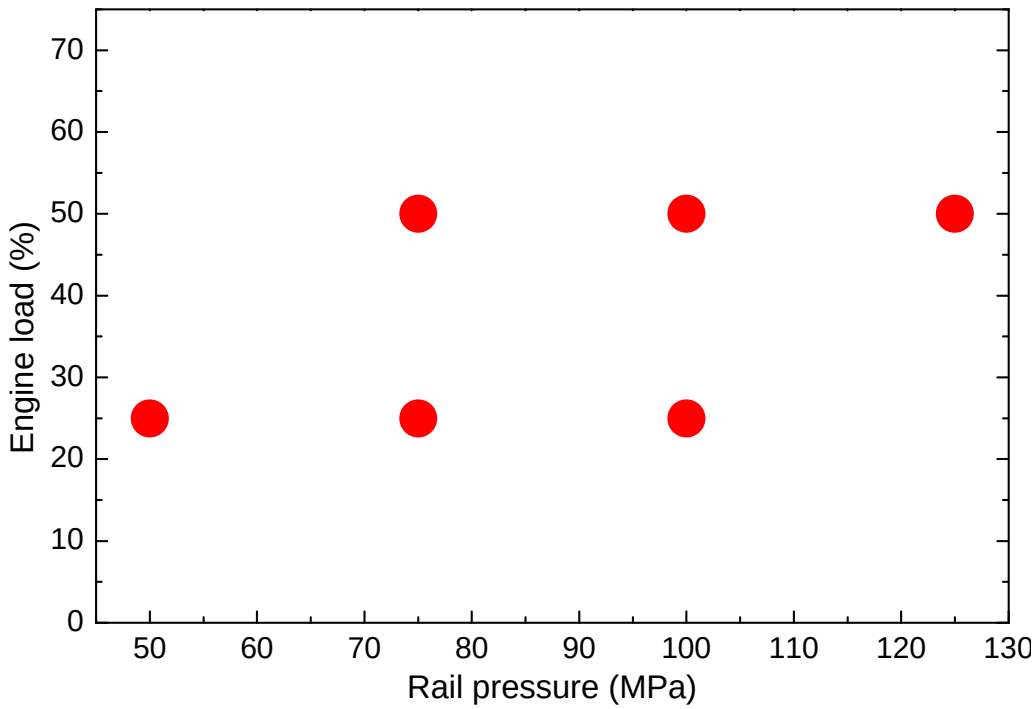
- Engine operating conditions
  - Lower speed or higher load increase the size of primary particles (Lapuerta et al., 2007)
- Injection strategy
  - Soot from retarded SOI is more reactive (Yehliu, 2010)
- Biodiesel fueling
  - May increase the number of smaller particles (Lapuerta et al., 2008)
  - May increase fractal dimensions (Tzamkiozis et al., 2011)
  - B20 generates more amorphous soot nanostructure (Boehman et al., 2005)

Objective

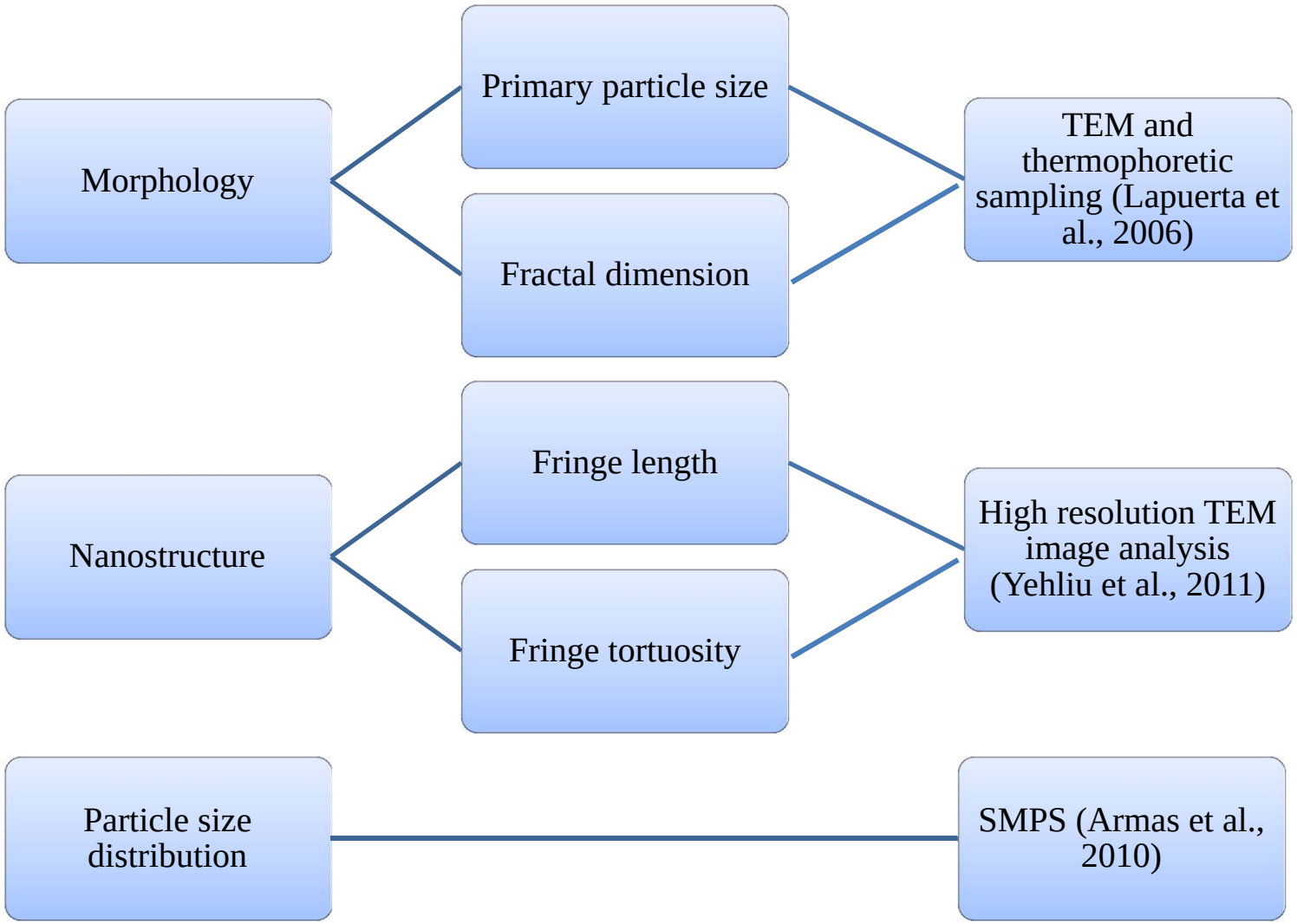
- Impact of rail pressure on
  - Particle size distribution
  - Soot morphology
  - Nanostructure
  - Oxidative reactivity
- The combination of rail pressure and biodiesel fueling

Experimental design

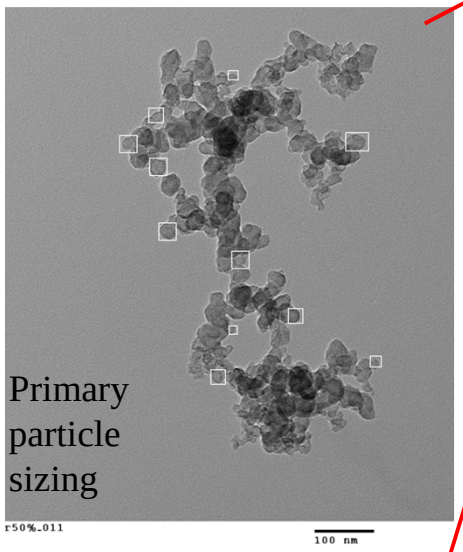
- Engine: 6.4L Ford “Powerstroke” turbocharged DI diesel engine
- Fuel: ULSD and biodiesel-ULSD blends
- Single injection, fixed engine speed of 1500 rpm, fixed SOI, EGR and boost pressure

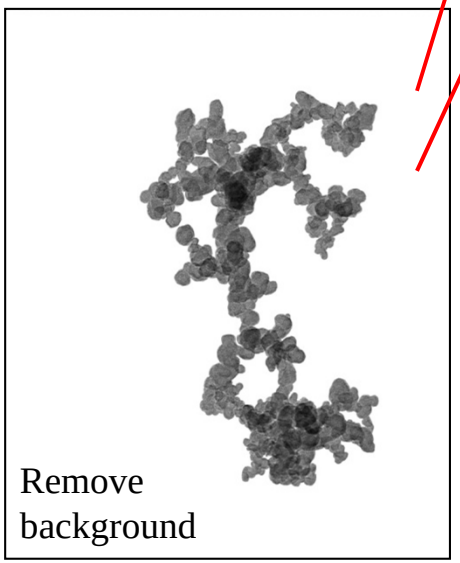


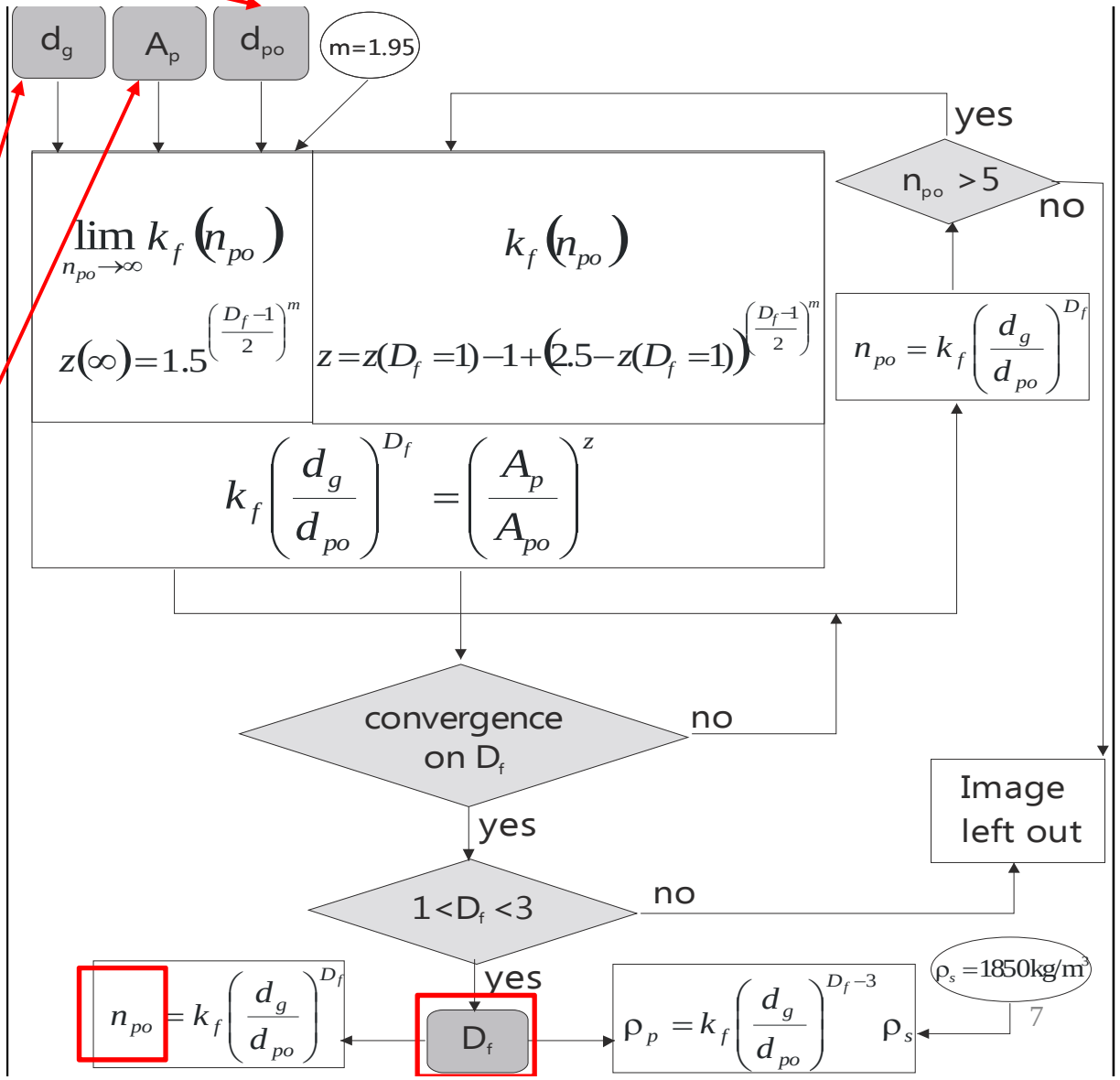
Characterization techniques



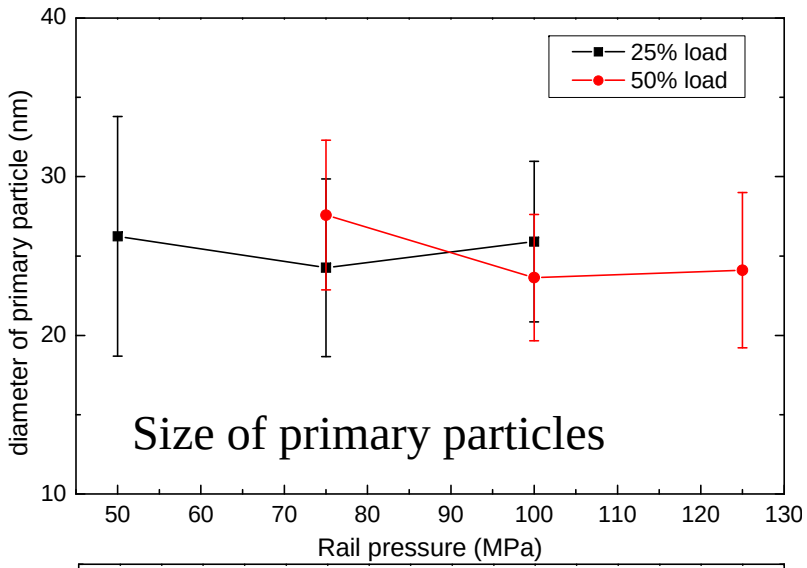
Morphology analysis procedure

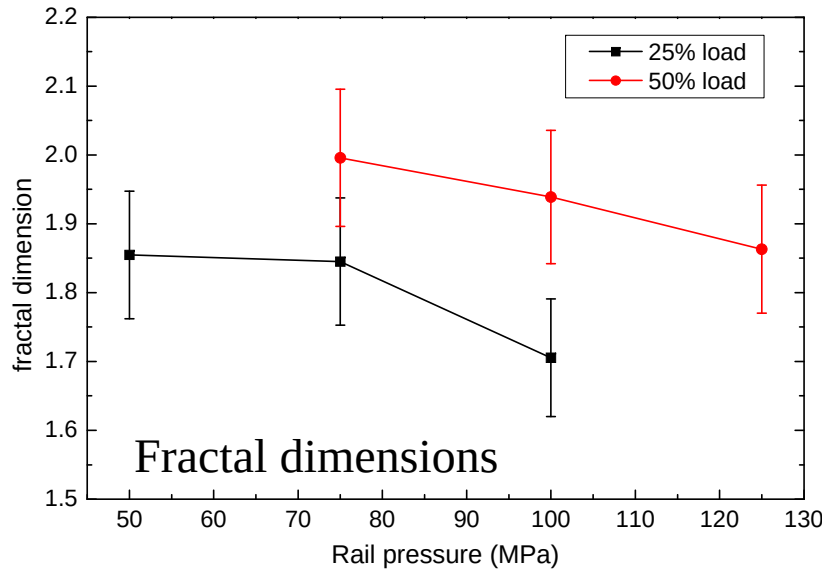


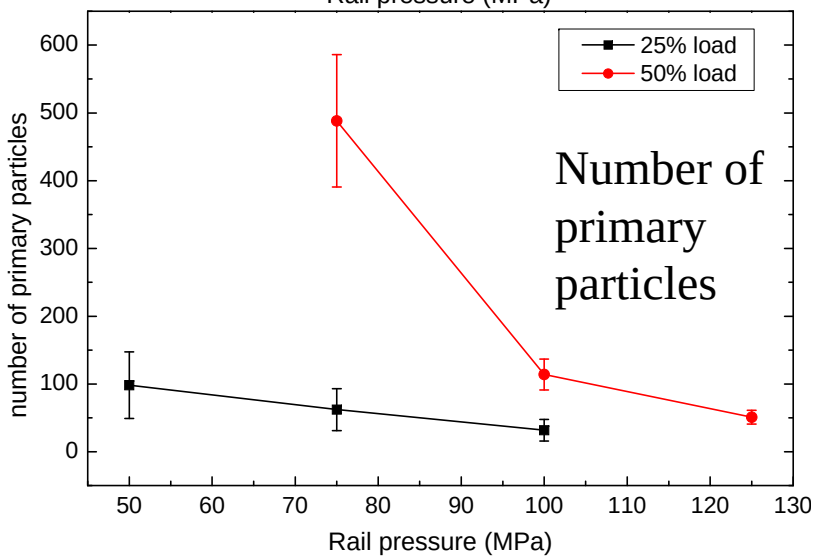




Current status:
Impact of rail pressure on PM morphology

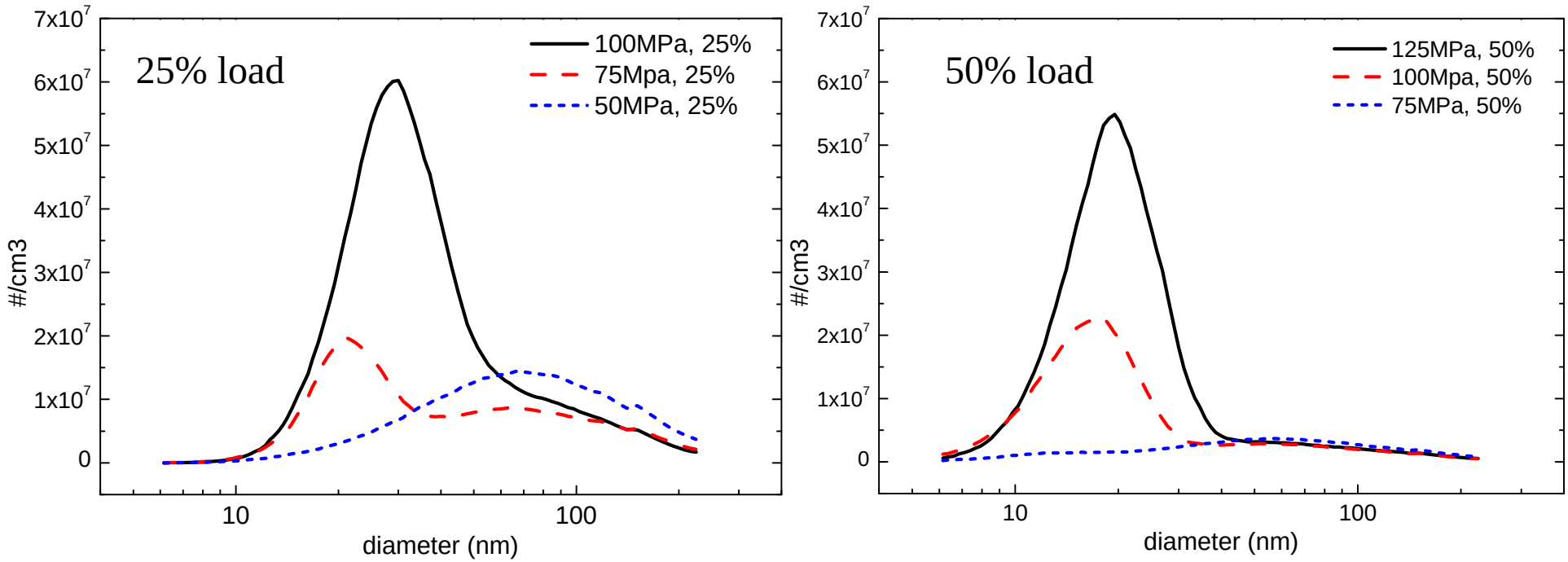






- Size of primary particles
  - No impact from rail pressure or engine load
- Fractal dimensions and number of primary particles
  - Decrease with higher rail pressure; increase with higher load

The impact of rail pressure on particle size distribution from engine exhaust



- Higher rail pressure increases the nucleation mode peak and decreases the accumulation mode peak
- Higher load decreases the accumulation mode peak

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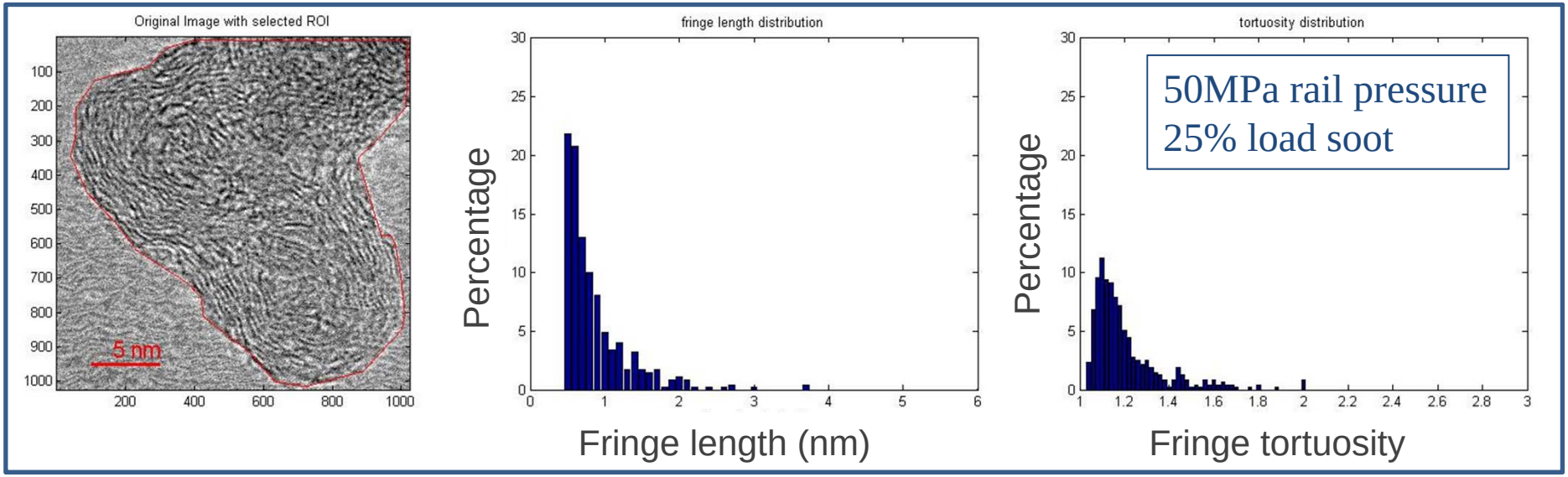
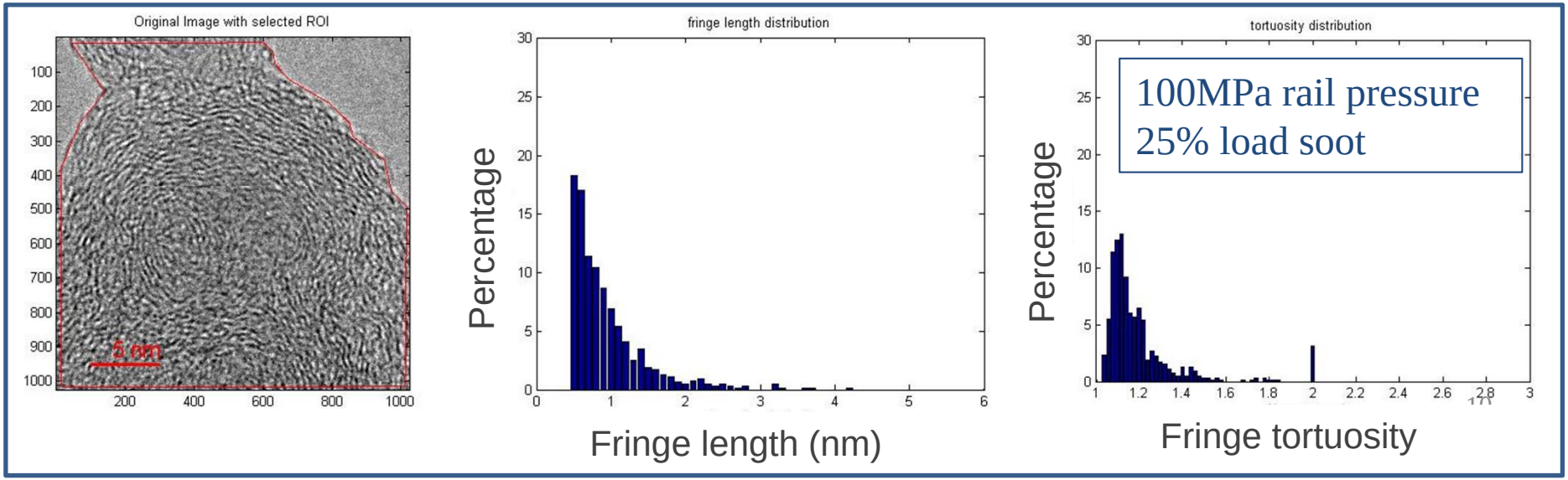
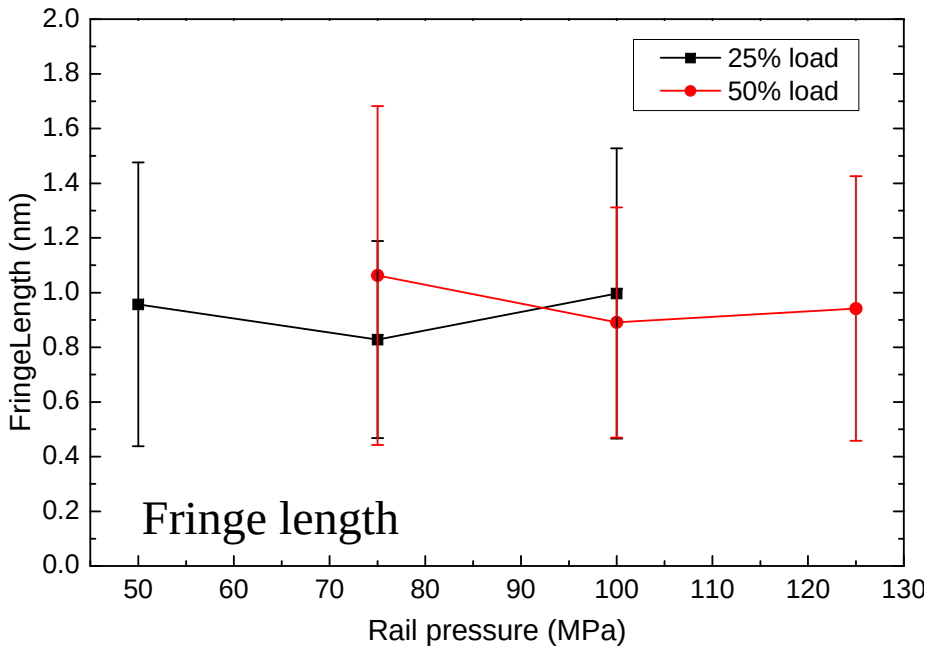
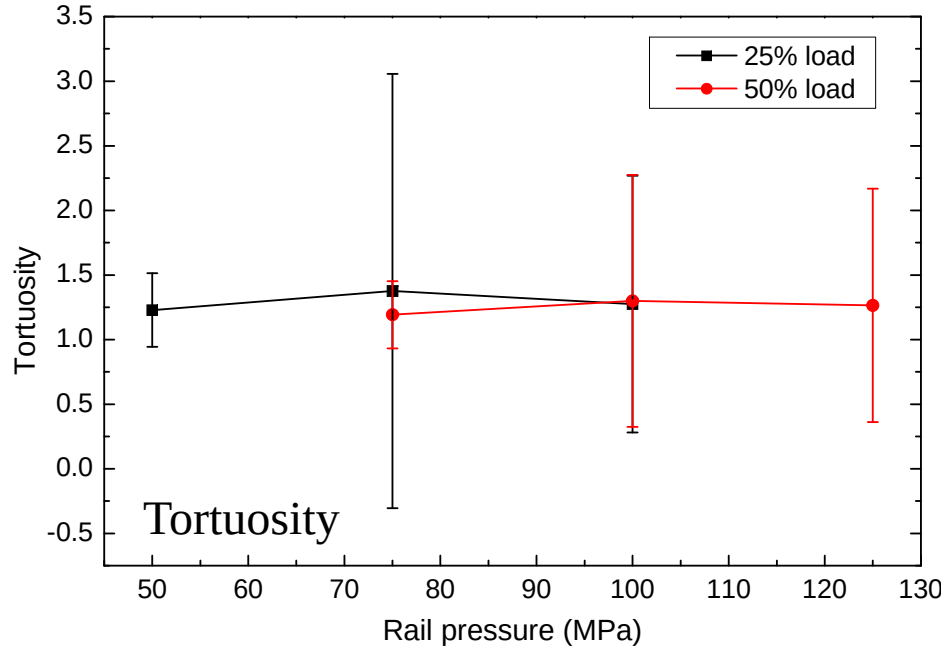
Impact of rail pressure on soot nanostructure





Soot nanostructure trends





- Fringe length
  - No significant difference
- Tortuosity
  - No significant difference

Summary and future work

- Rail pressures investigated
  - 50-100 MPa at 25% load; 75-125MPa at 50% load
- Higher rail pressure
  - Decreases the mean number of primary particles per agglomerate
  - Increases the nucleation mode peak in PSD
  - Decreases the fractal dimension of PM
  - No significant impact on primary particle size and nanostructure
- Higher engine load
  - Increases the mean number of primary particles per agglomerate
  - Increases the fractal dimension of PM
  - No significant impact on primary particle size and nanostructure
- Future work
  - Soot characterization with TGA, Raman, BET, XRD and XPS
  - Biodiesel fueling

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Thank you for your attention.

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