Passive NO_x Adsorbers for Diesel Applications

CLEERS Conference

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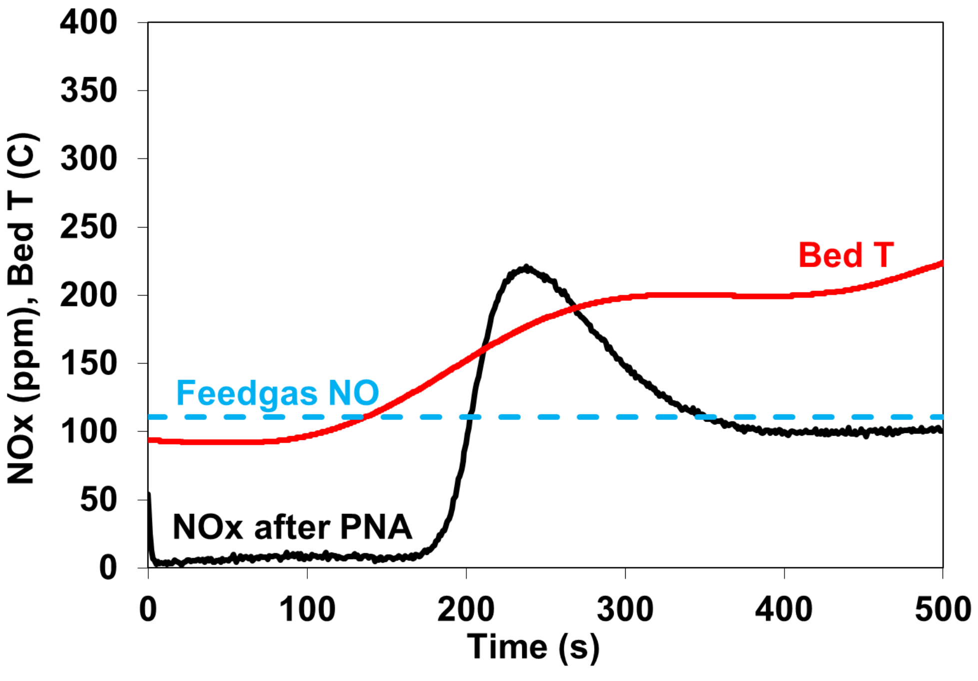
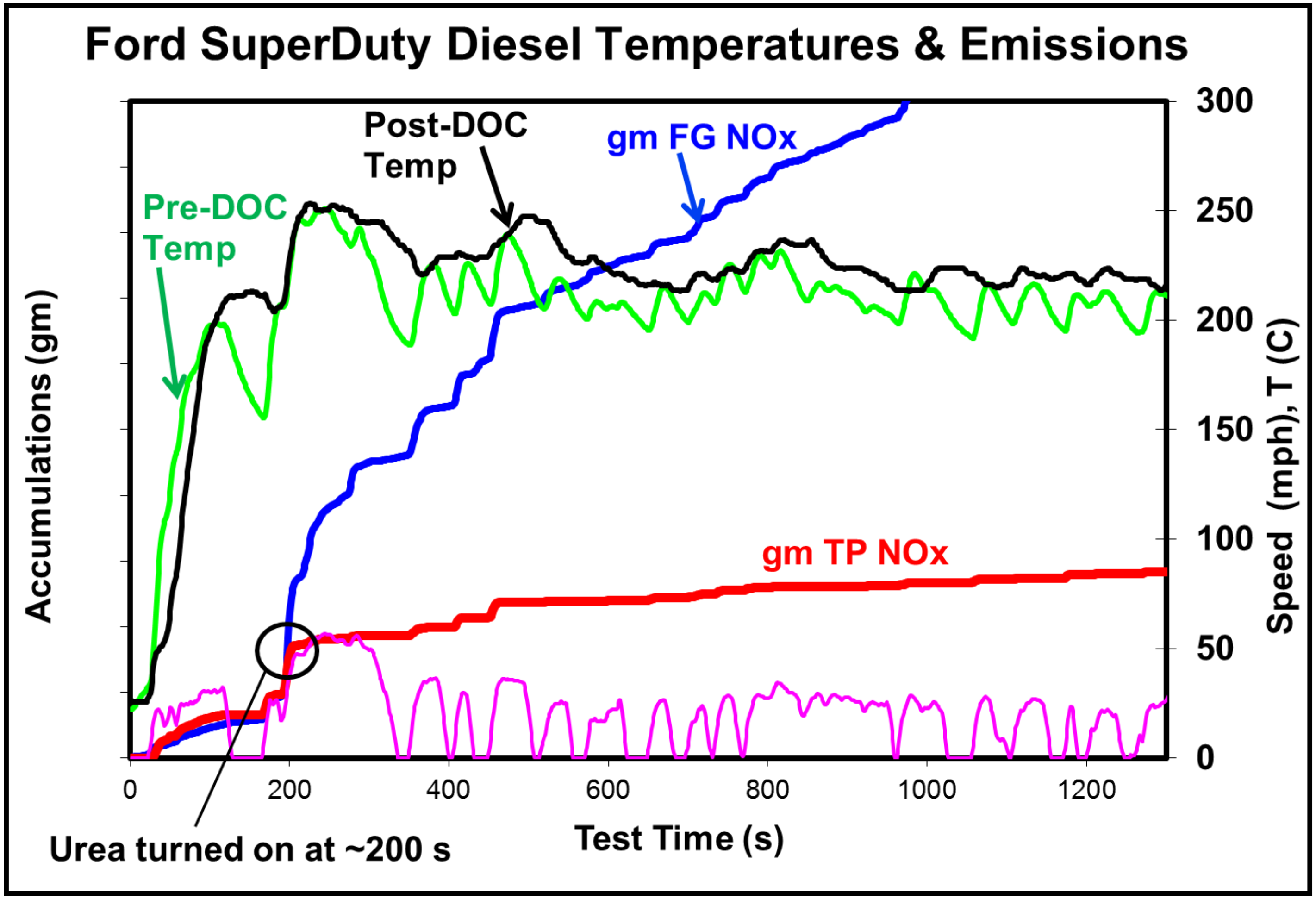


Background

- Urea/SCR systems effective for NO_x control above 200°C
- Slow warm-up on diesels delays urea injection and NO_x abatement, requires extra fuel to accelerate warm-up
- PNA needed to adsorb NO_x at low T, release NO_x @ lean at higher T



- Pre/post-DOC Max T ~250°C
- Stab T in Bag 2 ~200°C
- Urea on at ~ 200 s

Low Temperature NO_x Adsorbers (LTNA)

Store NO (& NO_2) from engine during cold start period

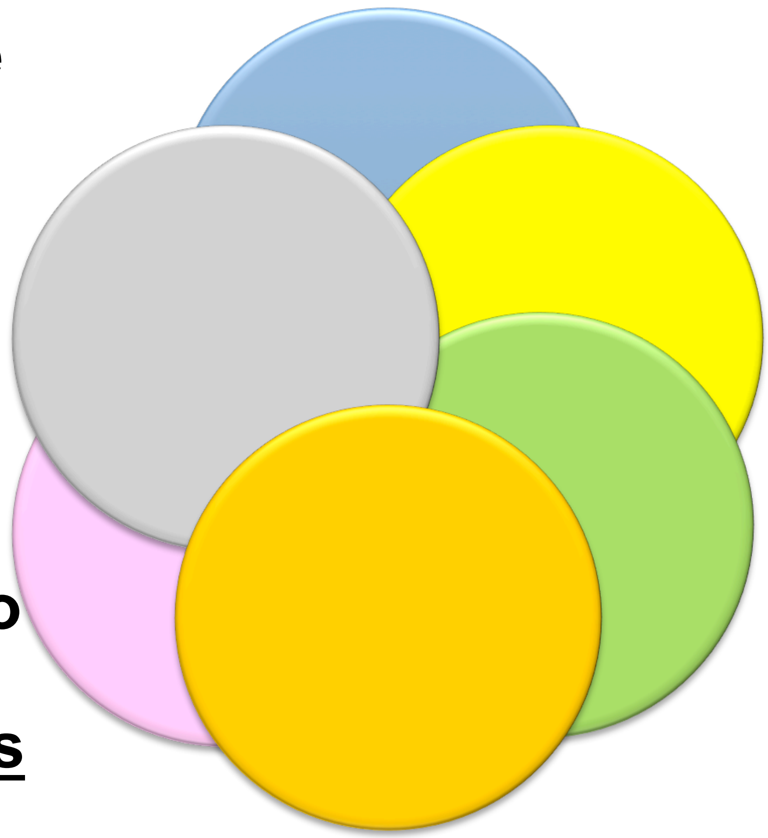
- 25 to 200°C

Release NO thermally <u>under lean conditions</u> at temperatures of FTP/US06

- Once urea/SCR system is operational
- 200 to 350°C

Cost Effective

- PGM loading
- PGM type
  - Pt vs Pd



Robust as possible to sulfur & able to deSO_x under <u>lean conditions</u>

- 650 to 750°C
- DPF regens

Minimal N_2O

- GHG Regulations

High temperature durability

- 800 to 850°C under lean conditions (e.g., high loads)

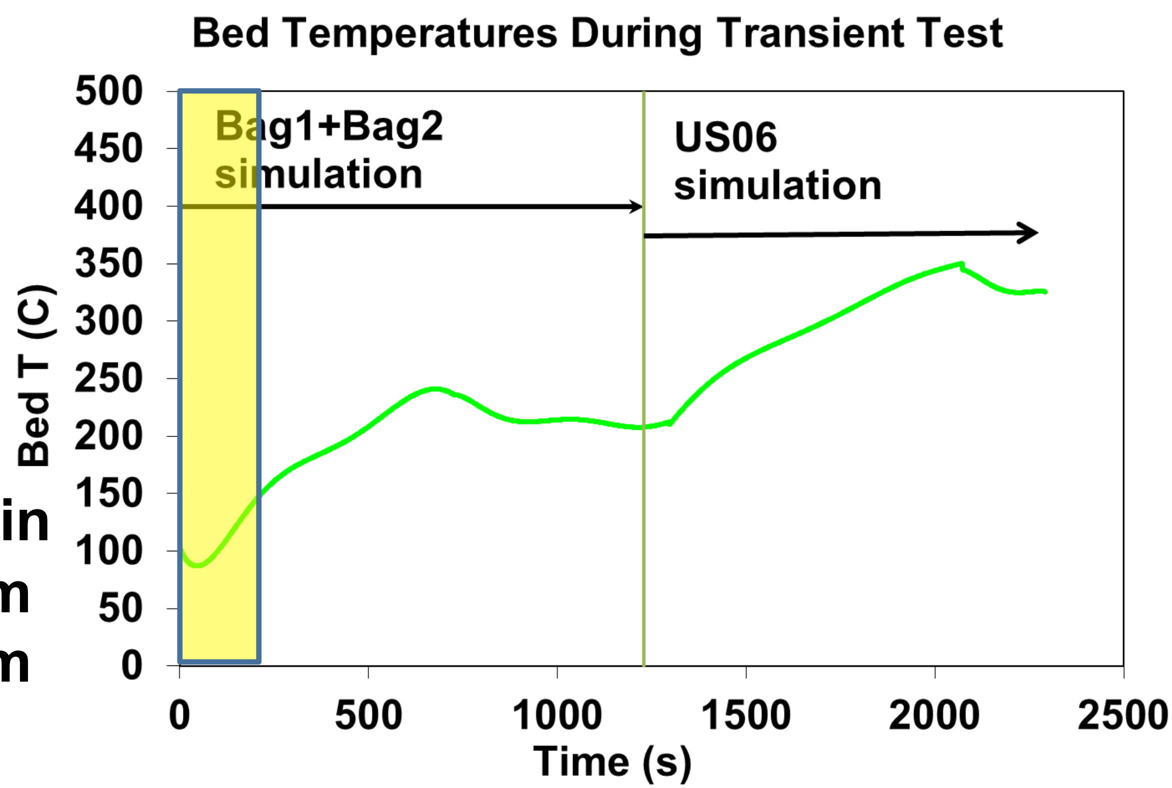
Transient Test on Lab Reactor

- Goal: simulate Bags 1 & 2 of FTP + US06 on SuperDuty Diesel
  - 250°C max during Bag 1, 200°C at end of Bag 2

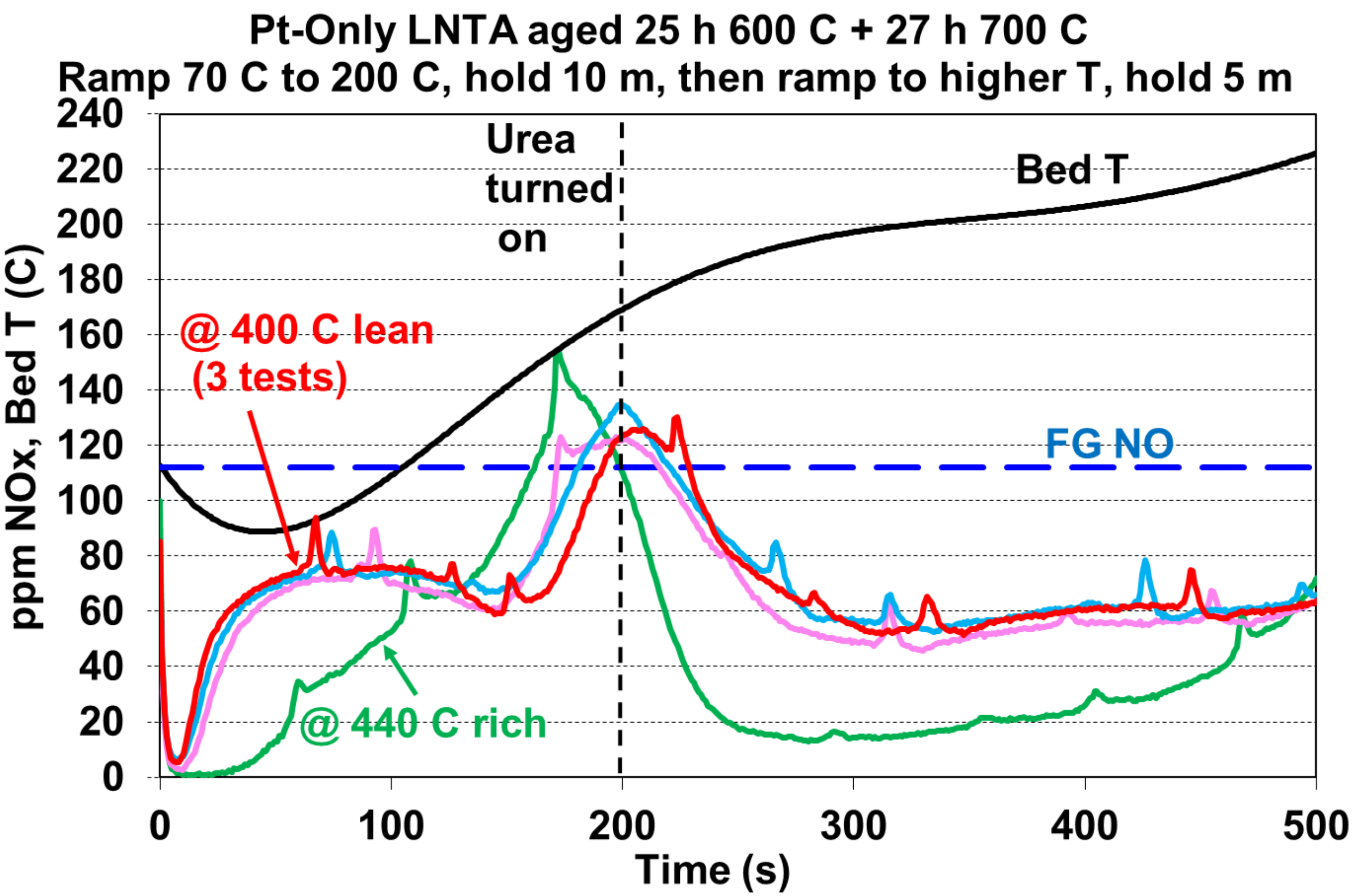
- In FG mode, stabilize
  - 100-110 ppm NO
  - 500 ppm HC (C1)
  - 5% H_2O/CO_2
  - 10% O_2

- In sample mode,
  - Ramp rate: 10°C/min
  - 70-175°C, hold 10 m
  - 175-300°C, hold 5 m

- Focus: Ave NO_x storage efficiency over first 200 s

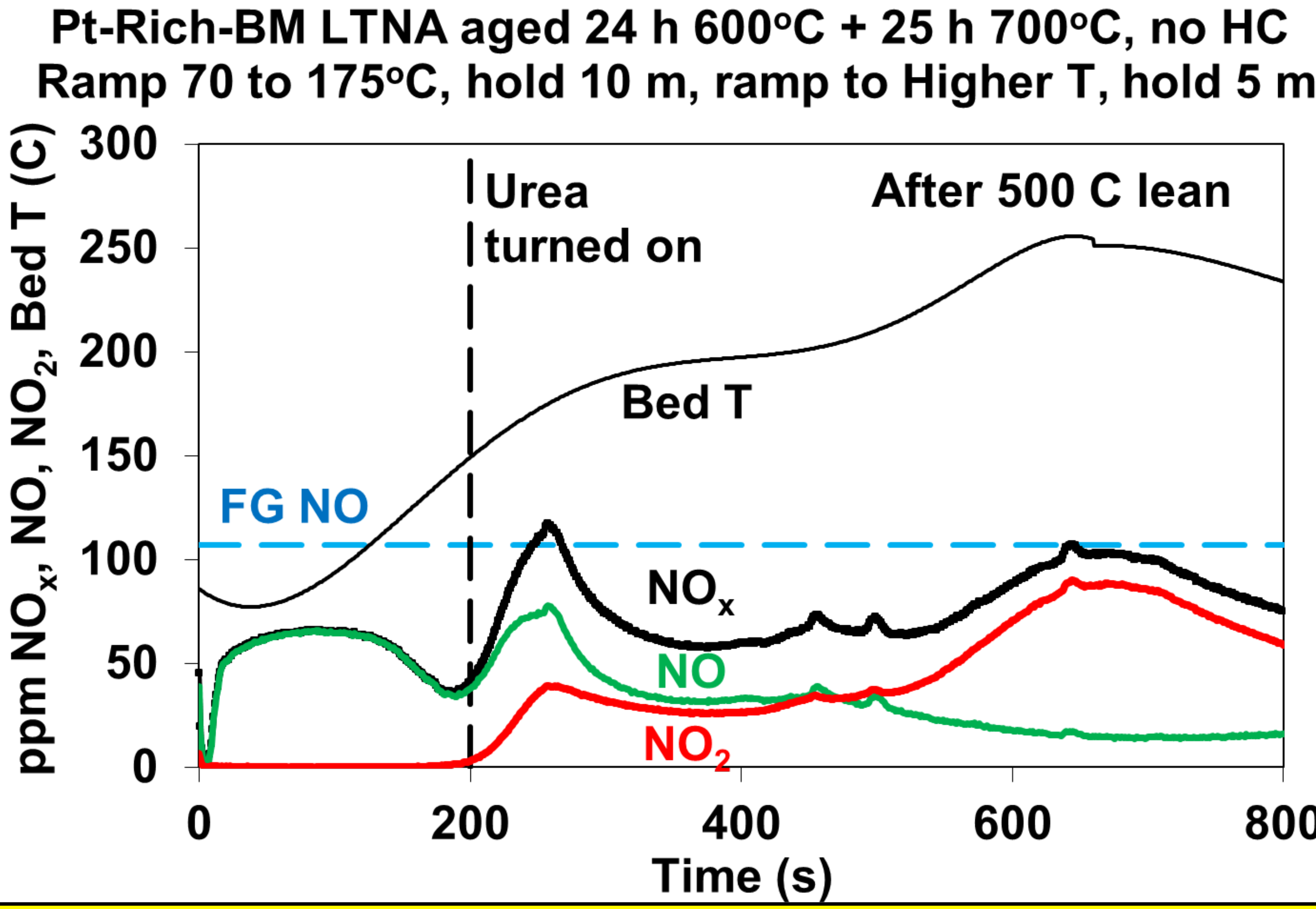


Transient Test on 180 gpcf Pt-Only LTNA



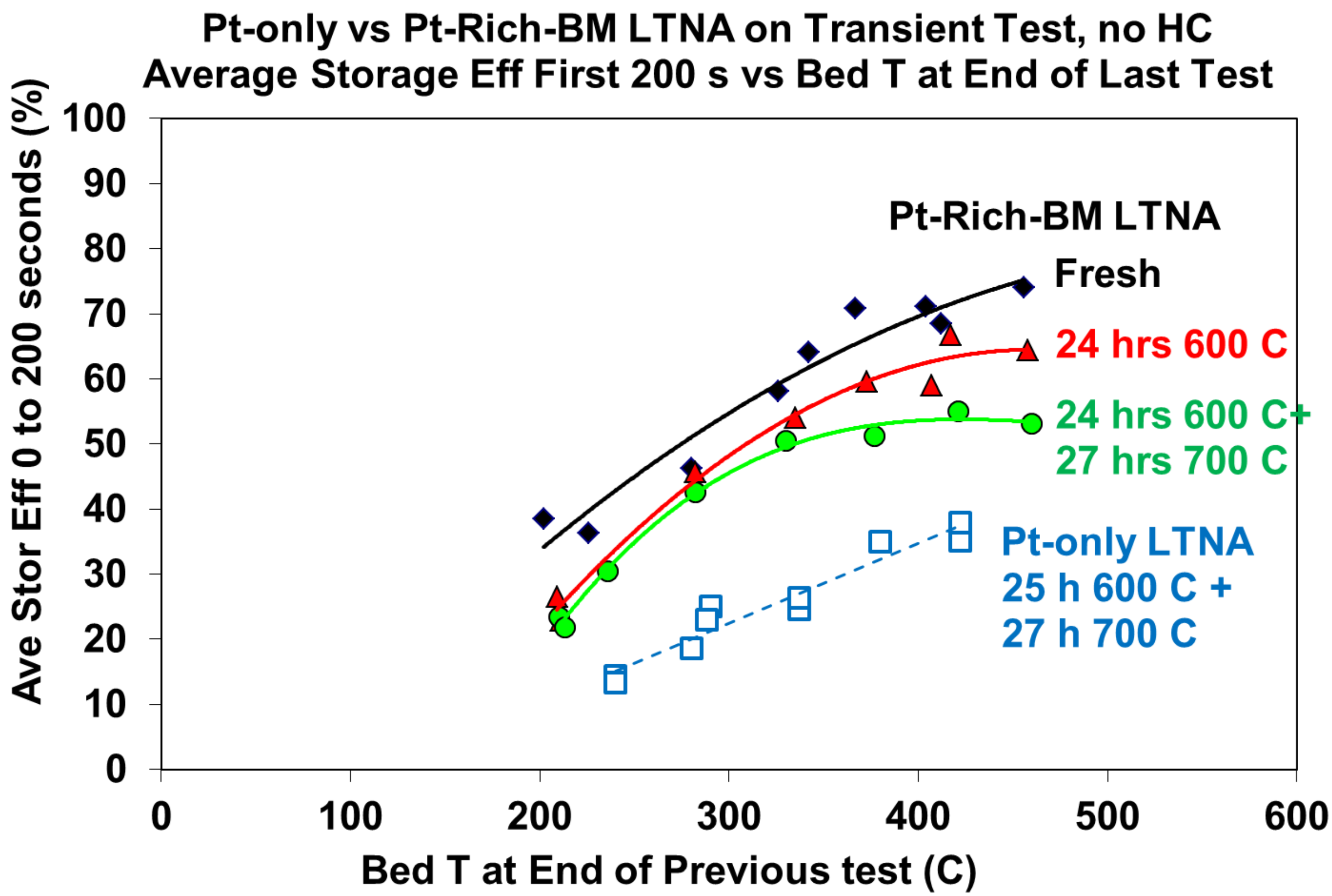
- NO_x slip high @ 400°C lean purges – poor NO oxidation, poor NO storage efficiency
- NO_x slip better after 440°C rich due to good purging, improved NO oxidation activity

Transient Test on 120 gpcf BM (2.4/1 Pt/Pd) LTNA



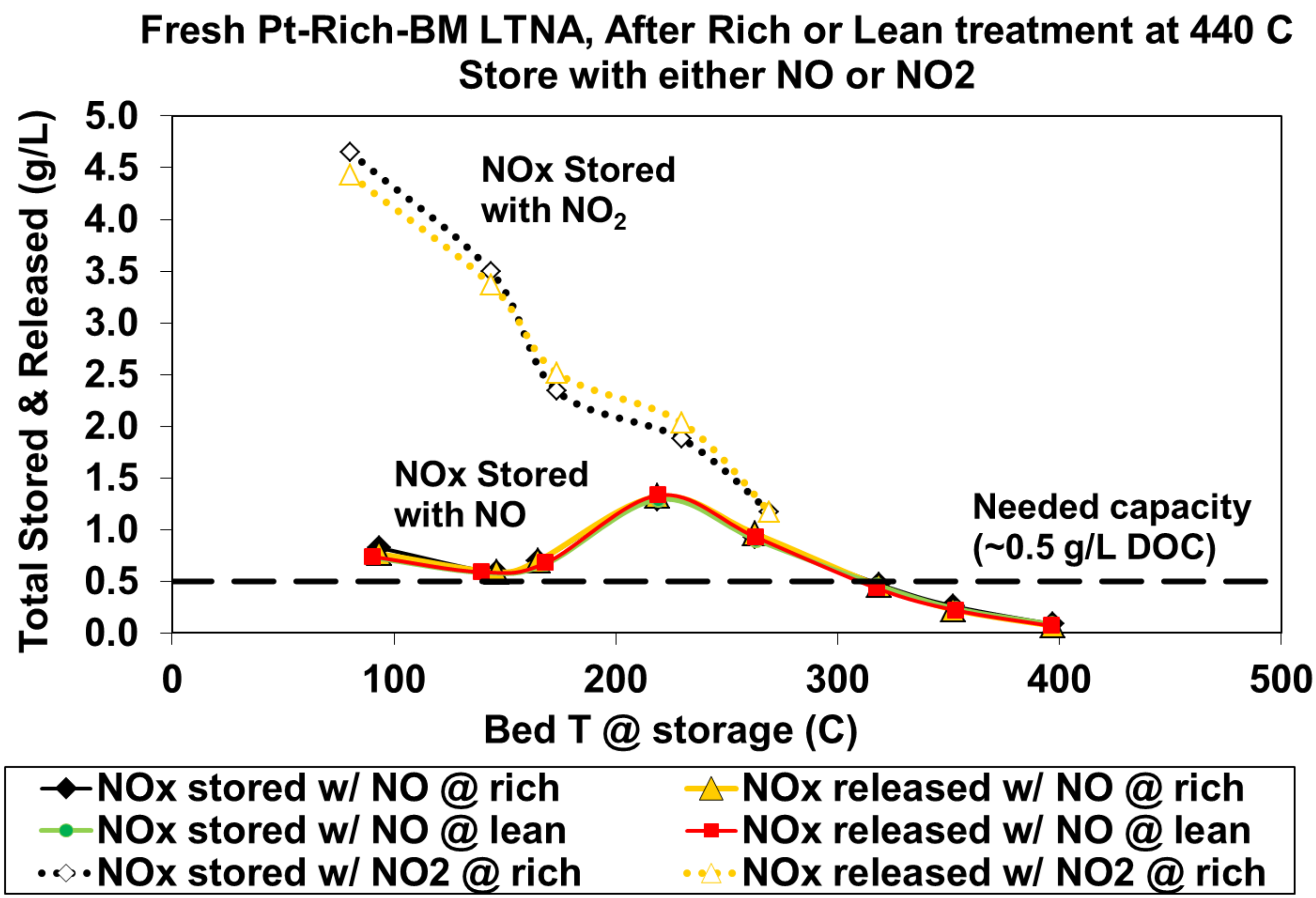
NO_x slip high during 200 second window
- Low NO oxidation + low NO storage efficiency
- NO_x released as both NO and NO_2

200 s NO_x Storage Efficiency vs Previous Max T



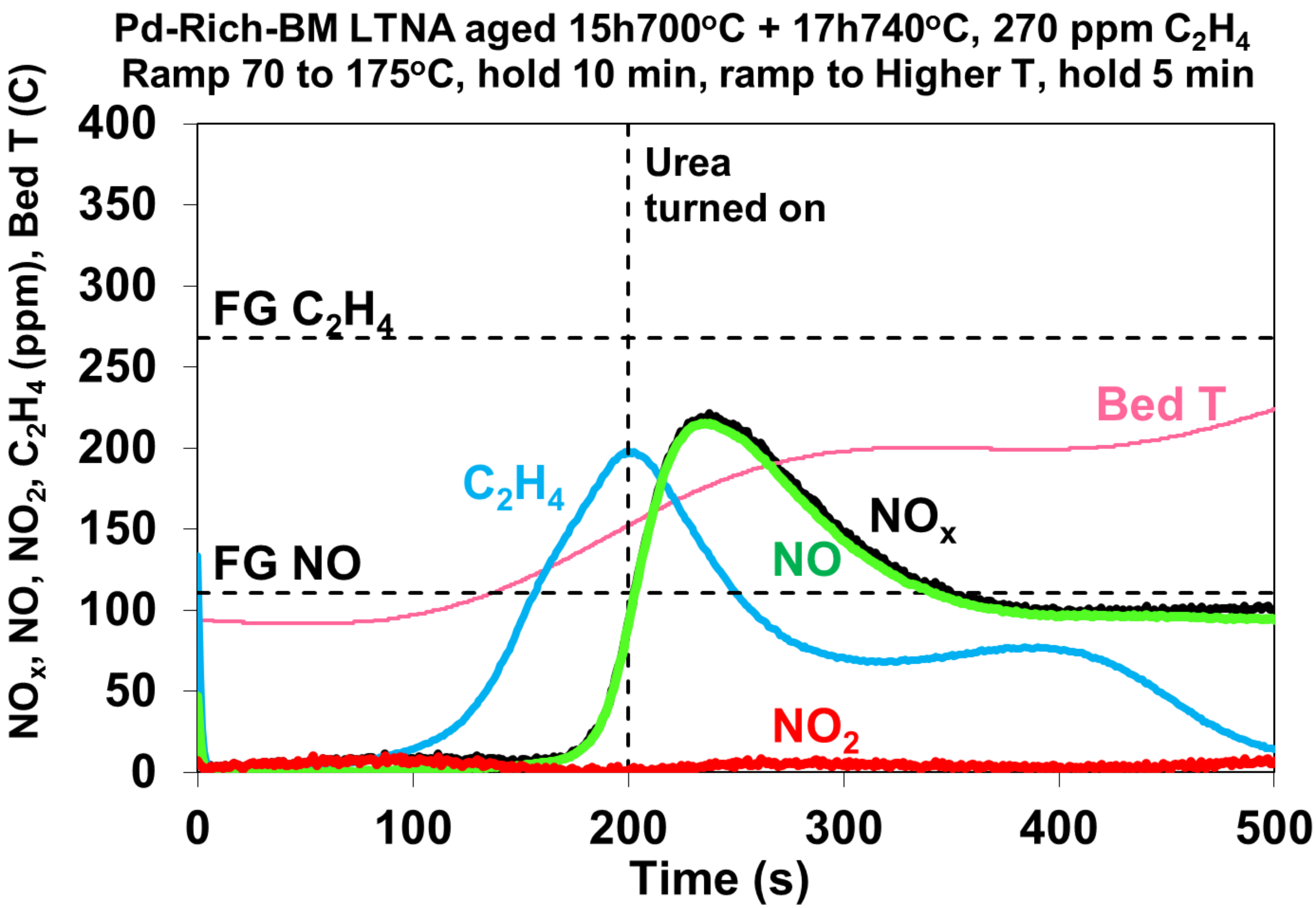
- Ave NO_x storage efficiency of Pt-Rich-BM LTNA decreased with aging
- Pt-rich-BM LNTA outperforms Pt-only LTNA after similar aging

NO_x Capacity of Fresh Pt-Rich BM LTNA with NO and NO_2



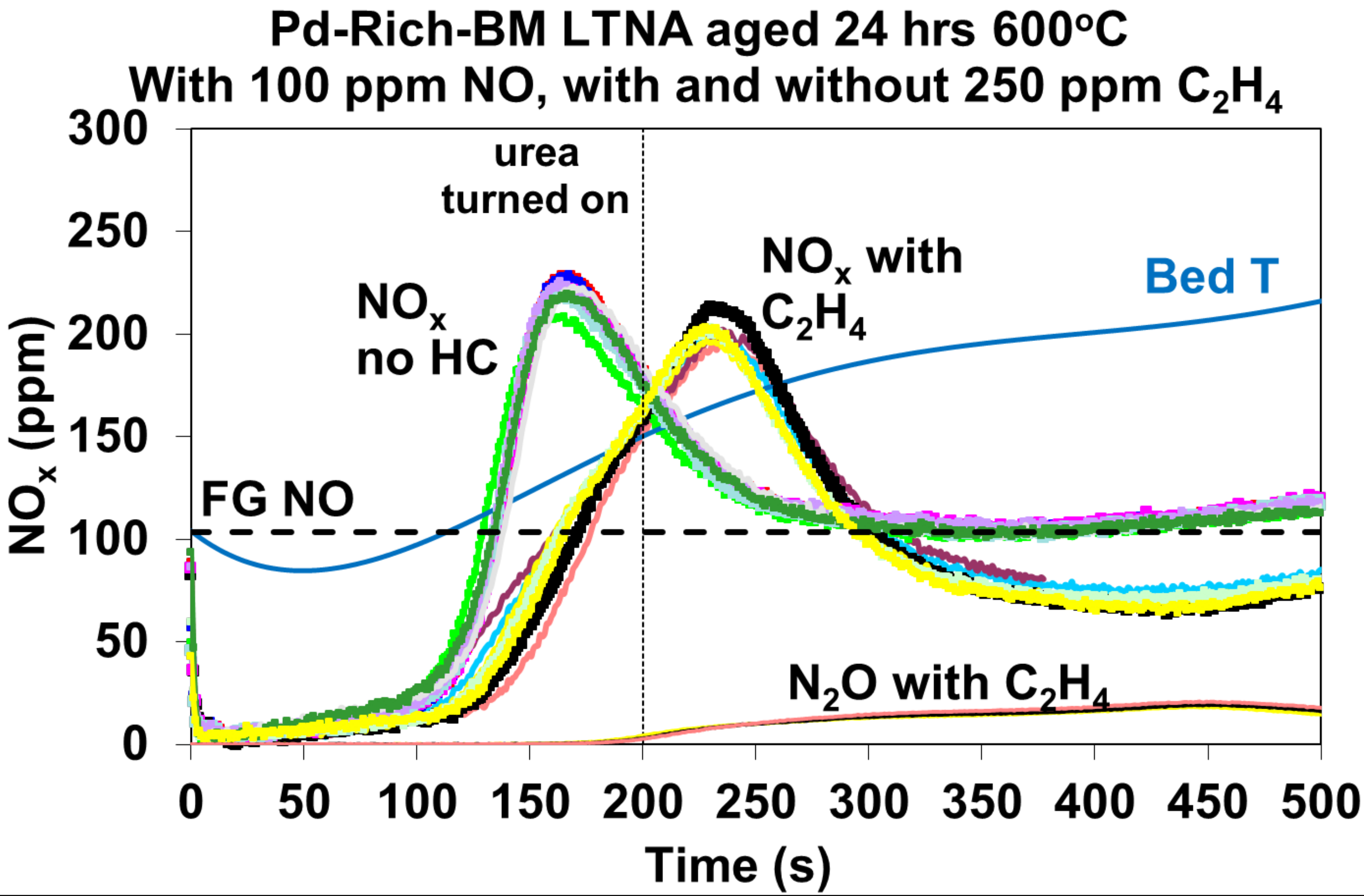
- Storage of NO below 250°C limited by NO oxidation

Transient Test on 118 gpcf BM (1/3.7 Pt/Pd) LTNA



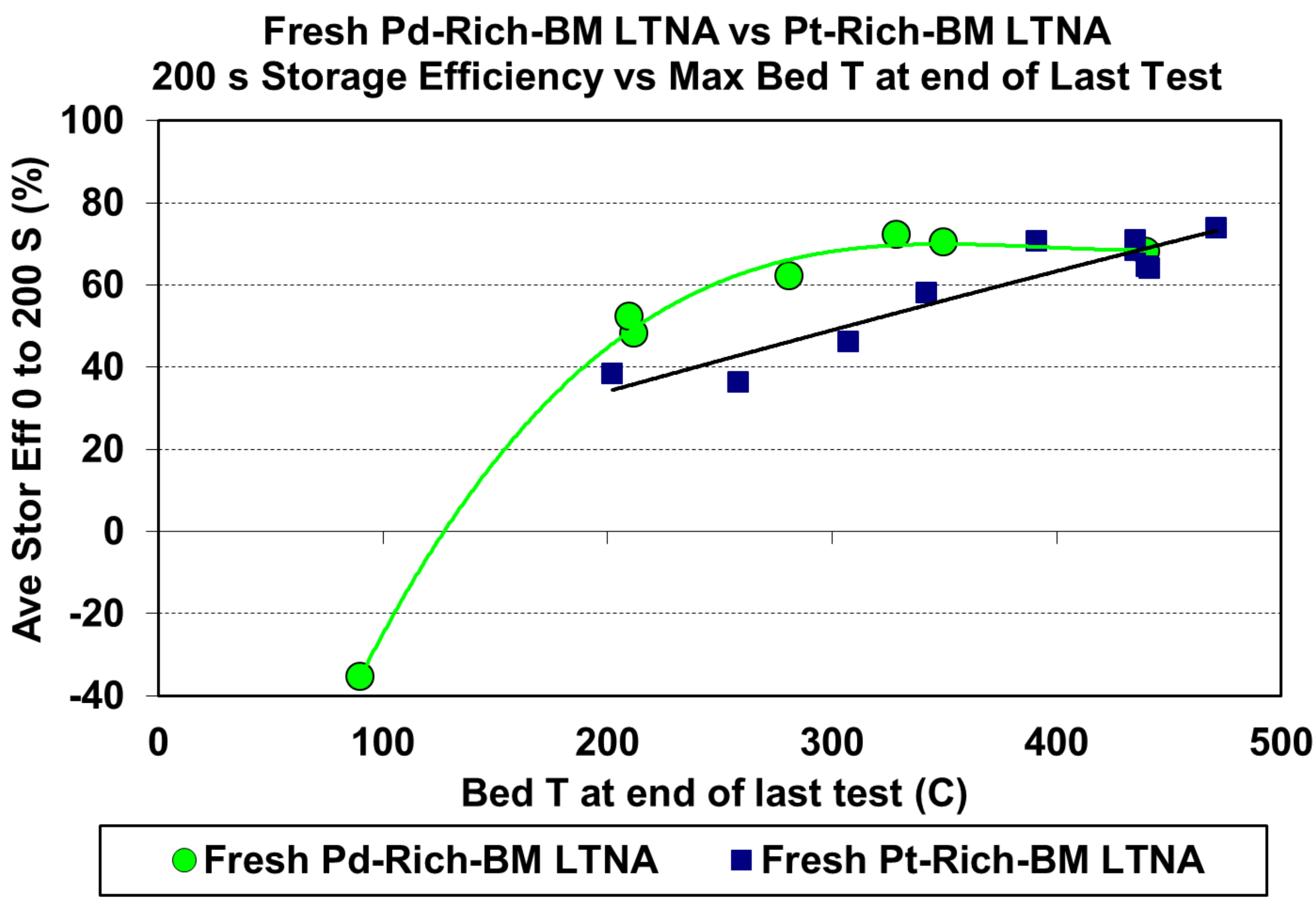
- Pd-rich-BM LTNA stored NO and C_2H_4 very efficiently at low T
- Stored NO_x released as NO → NO is stored directly at low T
- C_2H_4 never exceeds FG level, so stored C_2H_4 is converted

Ethylene Improves NO_x Storage Efficiency of Pd-Rich-BM



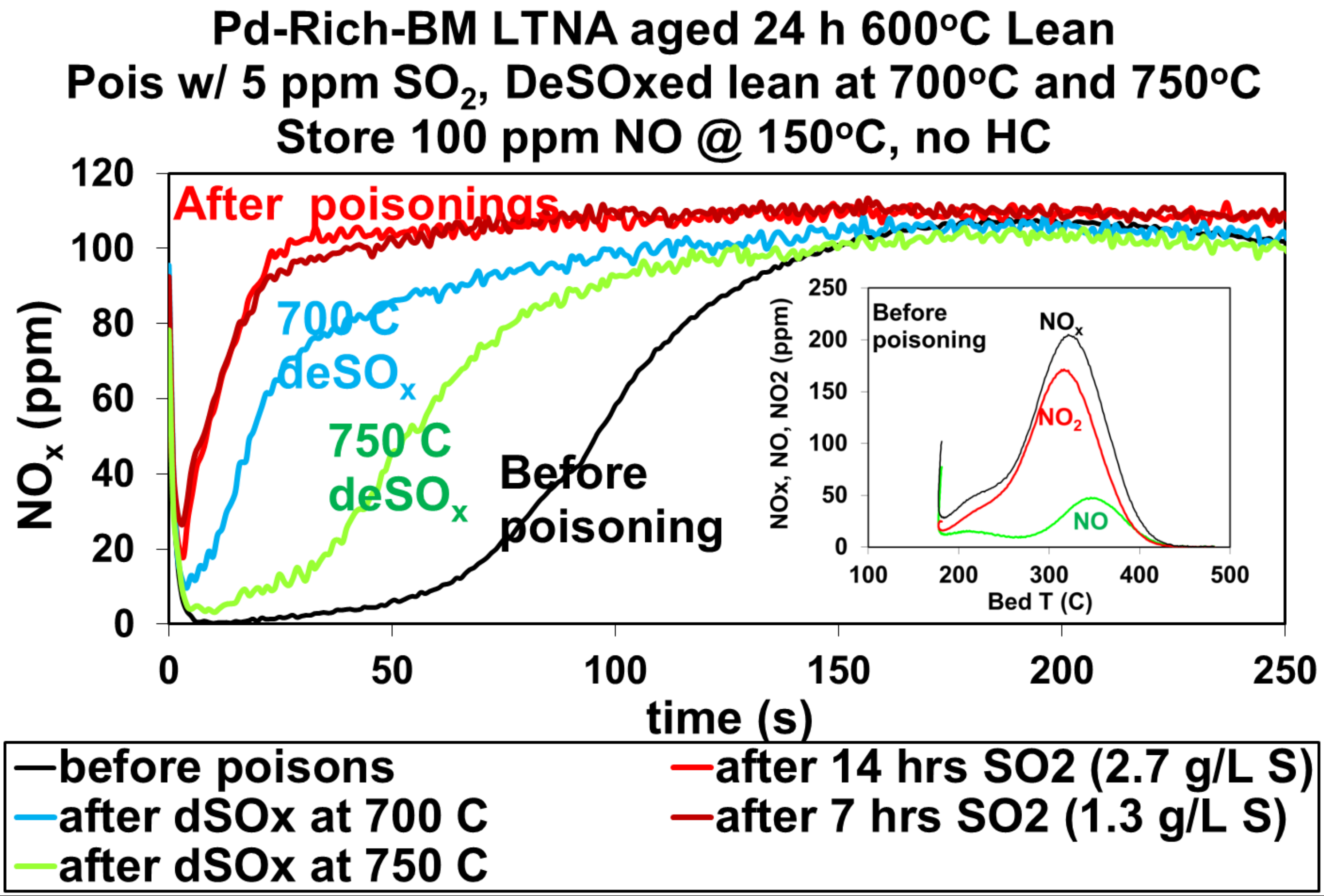
- Peak release of NO_x is delayed in presence of C_2H_4
  - NO and HC interaction below 160°C, delays NO_x release
  - HC-SCR above 160°C (i.e., beyond 200 s) as indicated by N_2O formation

Fresh 200 s storage efficiency of Pt-Rich-BM and Pd-Rich-BM LTNAs vs Prev Max T



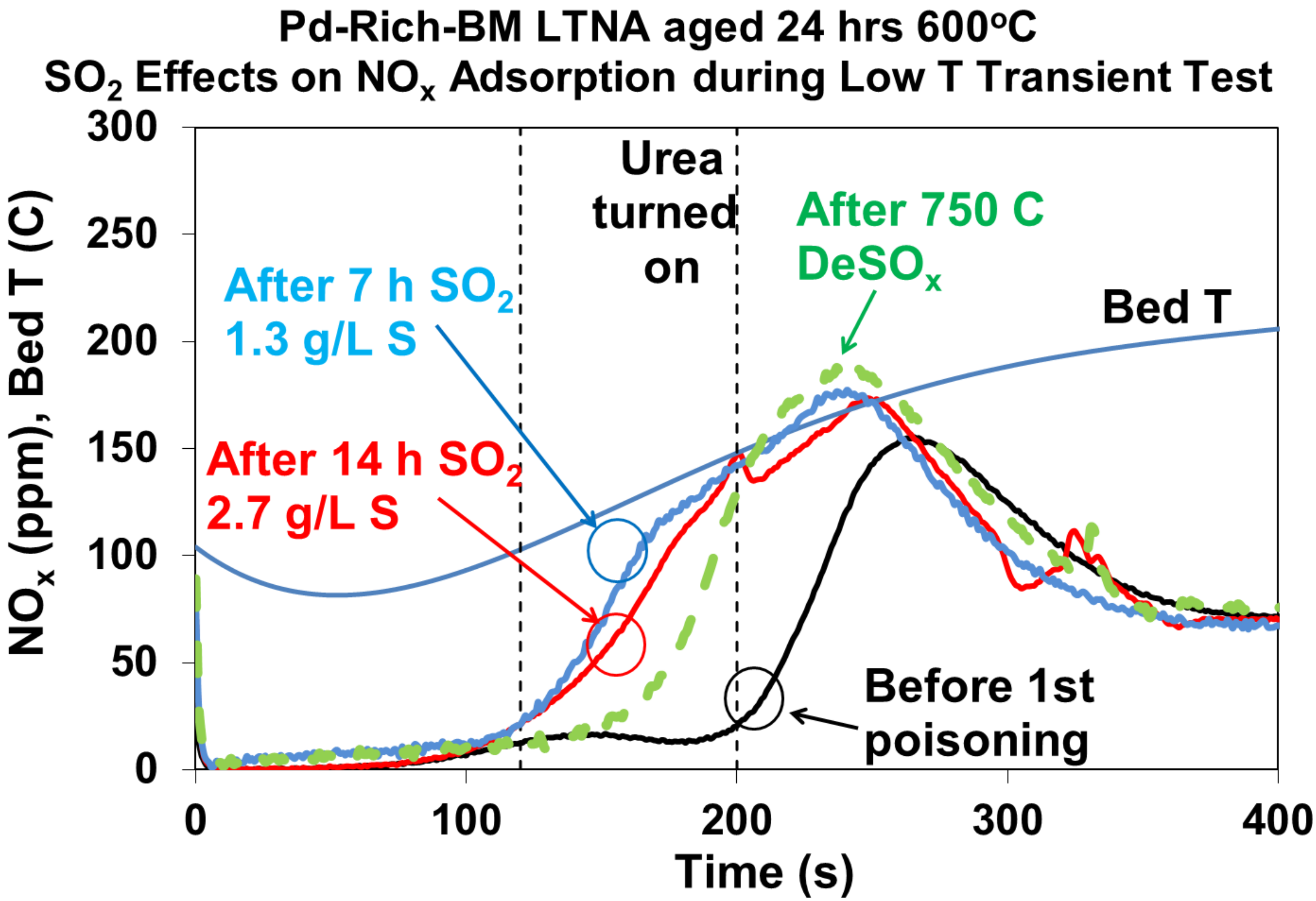
- Fresh Pd-rich LTNA achieved max performance after 330-350°C (US06)
  - Significantly lower than fresh Pt-rich LTNA (nitrates more stable)

SO_2 Effects on Pd-Rich-BM LTNA at 150°C SS



- NO_x storage at 150°C was degraded significantly by the SO_2
  - ➢ Some recovery after 700°C lean deSO$_x$, more after 750°C lean
- NO_x stored at 150°C released mostly as NO_2 → nitrate formation
  - ➢ Storage of NO_2 as nitrates is degraded by SO_2 poisoning

SO_2 Effects on Pd-Rich-BM LTNA during Transient Test



- However, NO still stored w/ high efficiency at low T for 120 s
  > NO storage as nitrites on Pd-Rich-BM LTNA more robust to SO_2