“New Developments in Titania-Based Catalysts for Selective Catalytic Reduction of NOx”

Cristal Global

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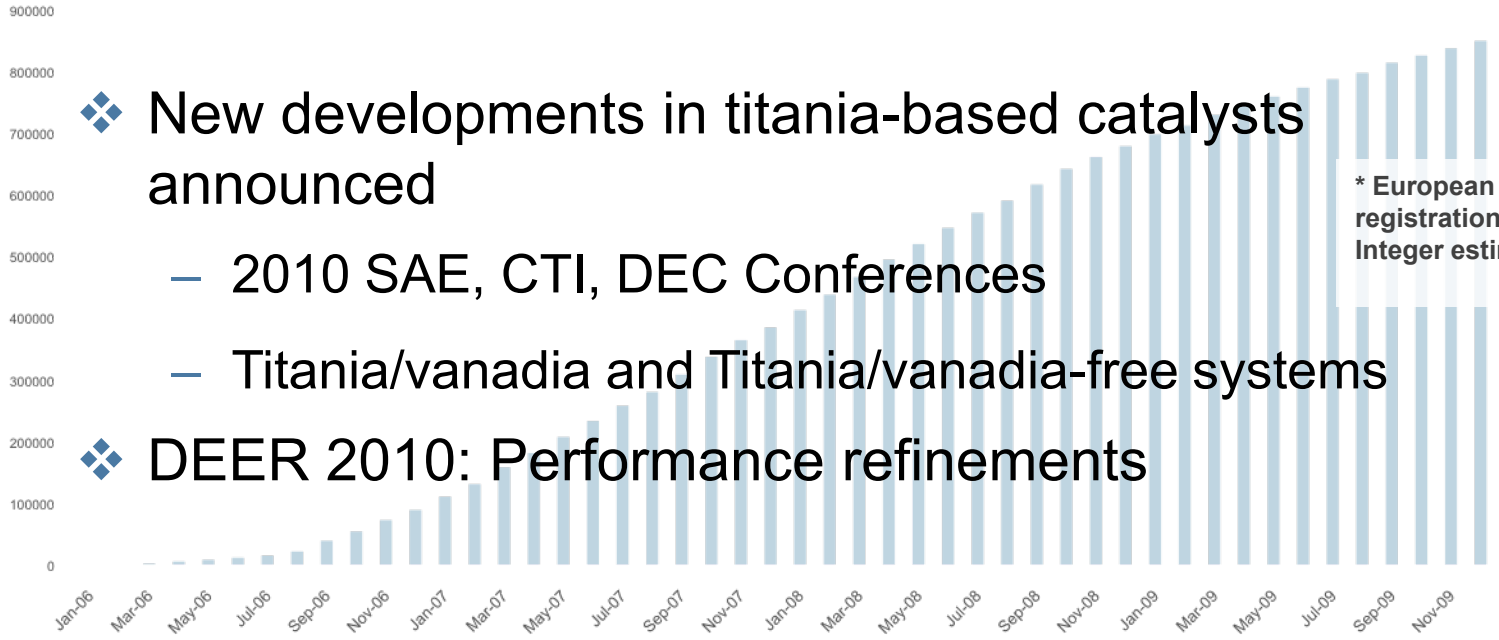
Mobile SCR Catalyst Snapshot

- Titania/Vanadia SCR catalysts were selected for Euro IV and V
  - Up to 900 000 vehicles are equipped*
- Zeolite catalysts were selected for on-road US 2010
  - Euro VI catalysts in development
- New developments in titania-based catalysts announced
  - 2010 SAE, CTI, DEC Conferences
  - Titania/vanadia and Titania/vanadia-free systems
- DEER 2010: Performance refinements



*** European SCR fleet registrations, 2009 Integer estimate**

New Titania Technology

- Basis for new catalyst is improved hydrothermal stability
  - Titania crystal chemistry and porosity (surface area) stability depend on:
    - Additive composition and microstructure
- Supports with improved stability then optimized for catalytic activity

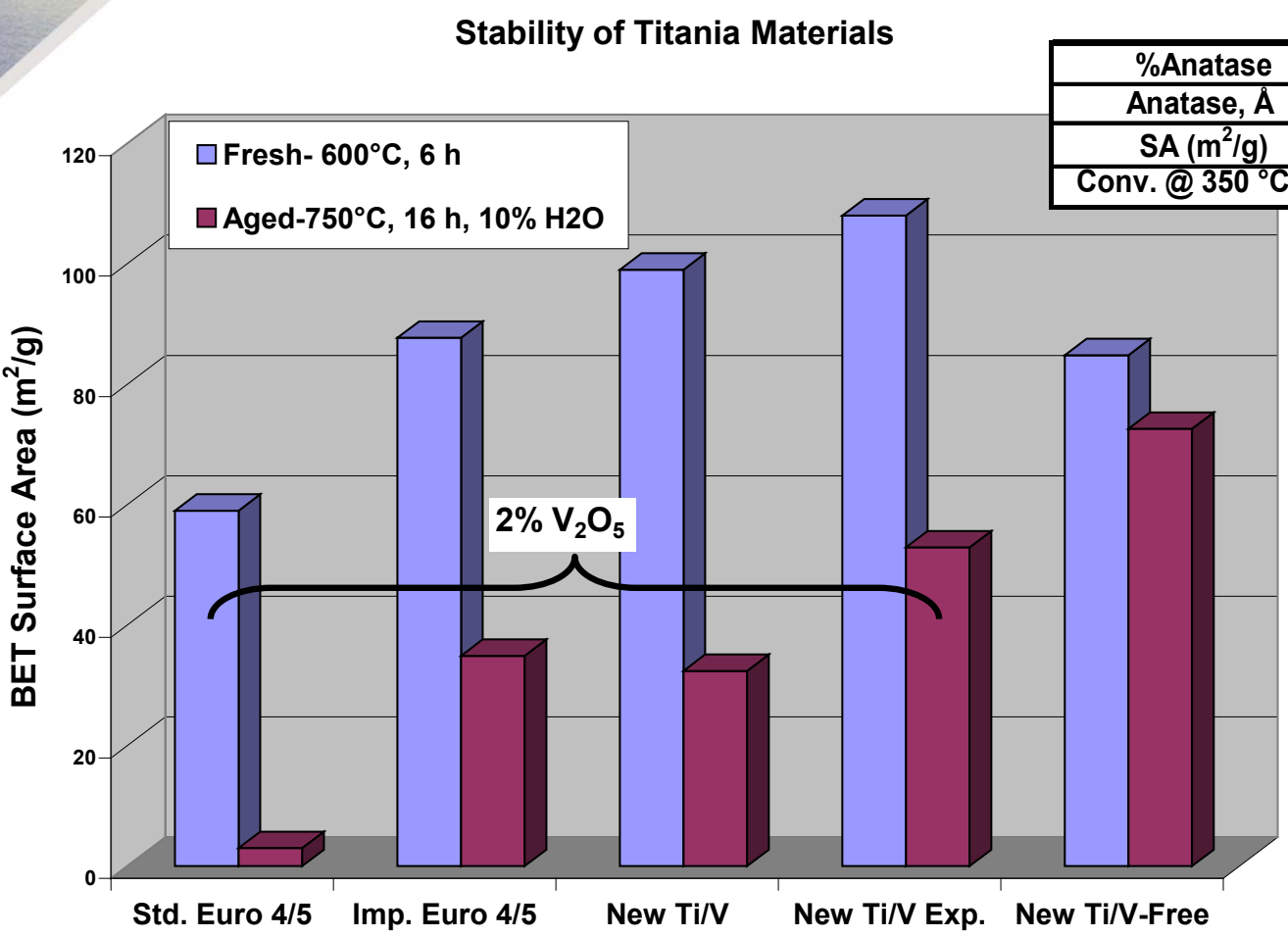
	Composition, wt%		
Material	**TiO_2**	**SiO_2**	**WO_3**
Std. Euro 4/5	90	0	10
Imp. Euro 4/5	81	10	9
Fe-beta zeolite			
New Ti/V-free	>80		
New Ti/V	90	4	6
New Ti/V Exp.	88	8	4

Stability of New Titania Materials

Ti/V Catalysts with 2 wt% vanadia

	Imp. Euro 4/5	Ti/V Exp.
%Anatase	85	100
Anatase, Å	1131	344
SA (m^2/g)	13	27
Conv. @ 350 °C, %	40	69

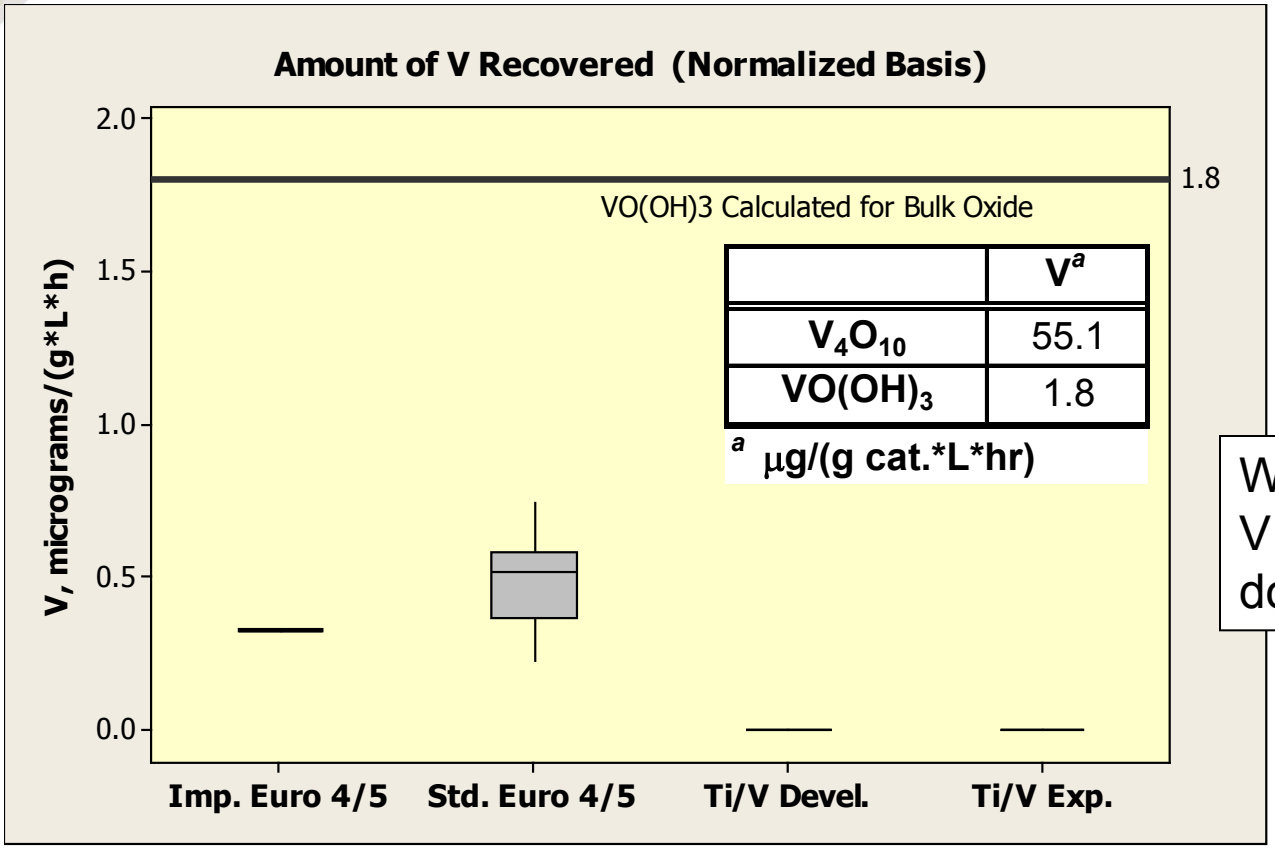
900 C, 1 h, 10% H_2O



- Retention of surface area and crystal phase is improved

Stability of Vanadia on New Materials

Volatile V at 750°C, 5% H_2O; 2 wt% V_2O_5



	V^a
V_4O_{10}	55.1
$VO(OH)_3$	1.8

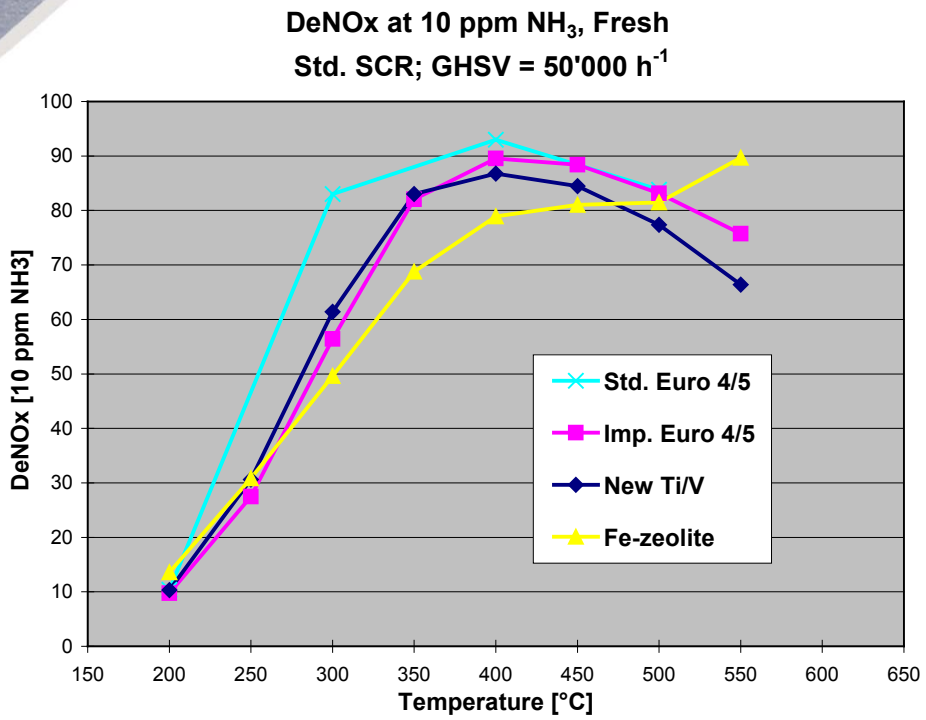
[a] μg/(g cat.*L*hr)

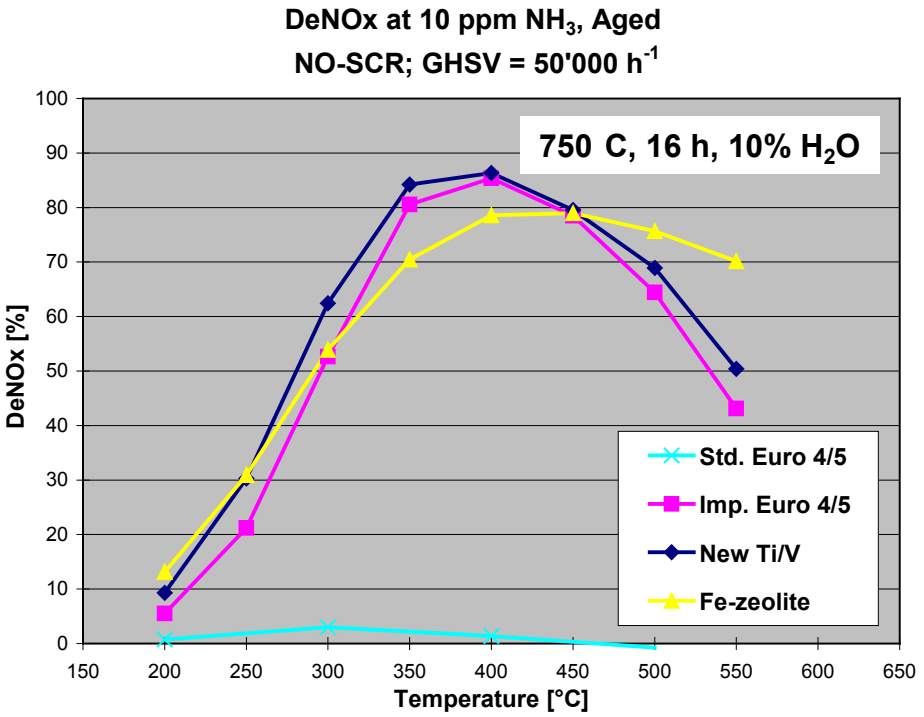
Without H_2O, no V is detected downstream

- Vanadia is strongly stabilized on titania
- Vanadia is further stabilized on new materials

New-Ti/V Performance: Activity

- Tests at Paul Scherrer Institute on wash-coated cordierite parts
- Standard SCR Reaction; 10 ppm NH_3 slip

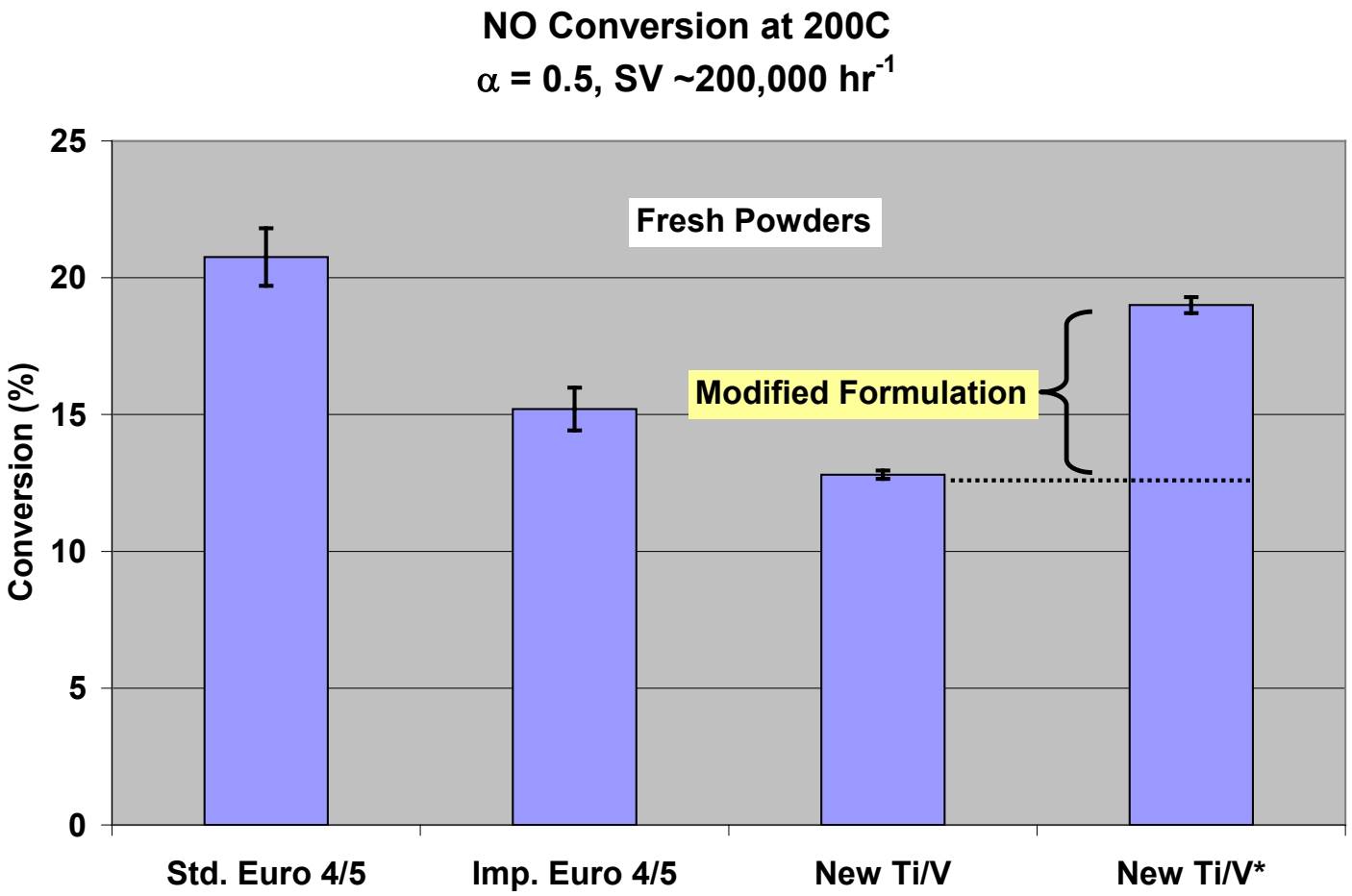




- New Ti/V has improved activity profile after hydrothermal aging.

New Ti/V Refinements- Low t Activity

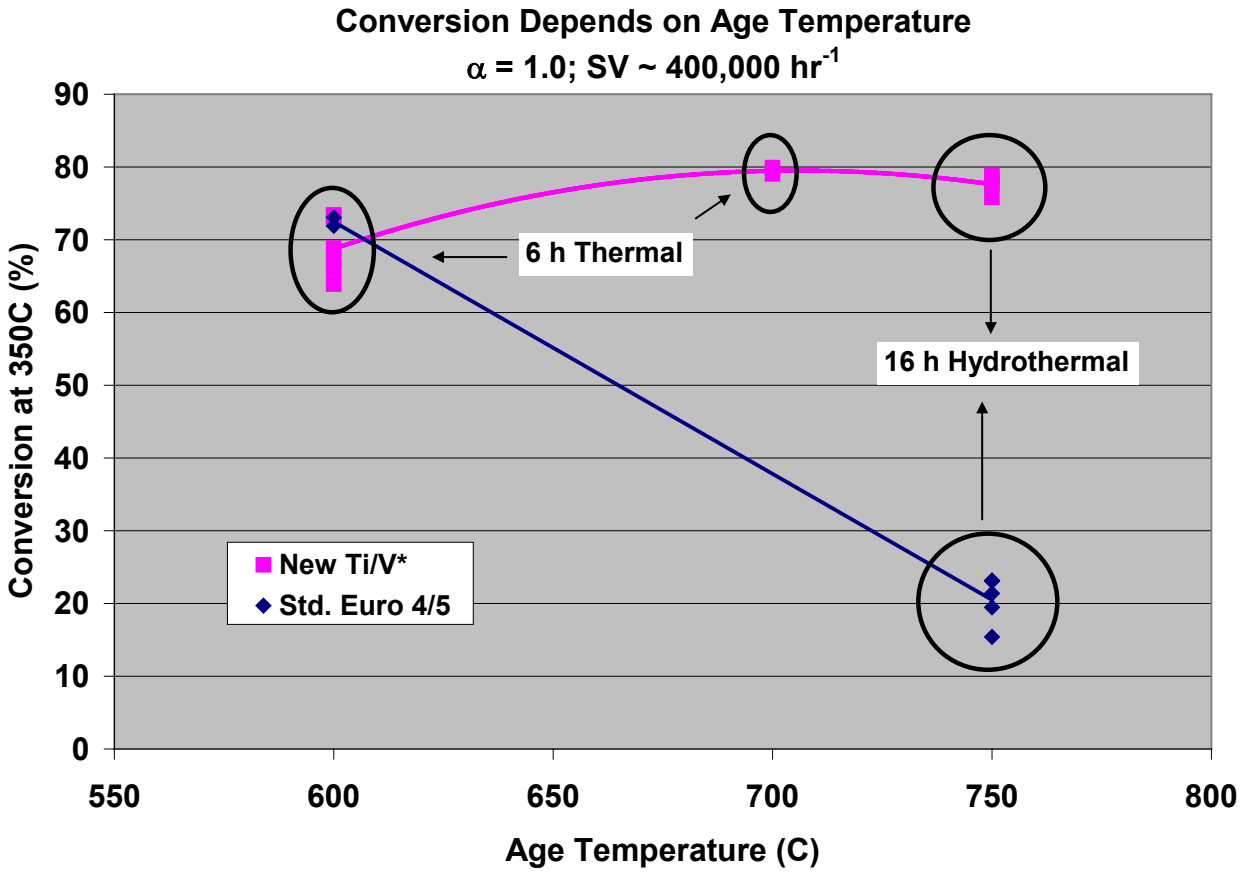
- Powder tests at $NH_3/NO = 0.5$



- New Ti/V* low temperature activity can be improved

New Ti/V Refinements- Activity + Stability

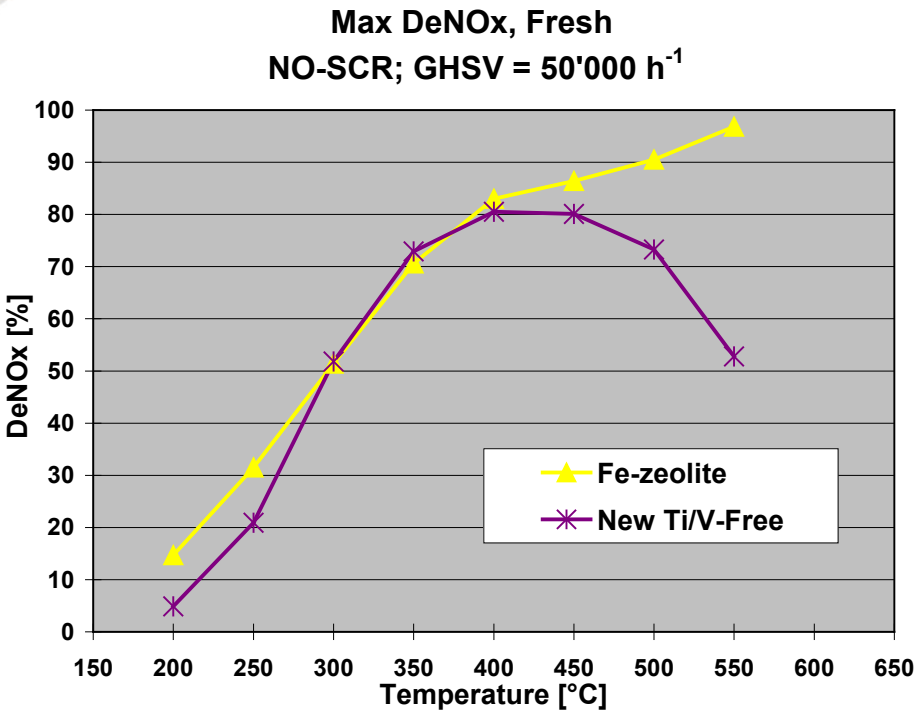
- Powder mixture tests at $NH_3/NO = 1.0$
- Representative formulations

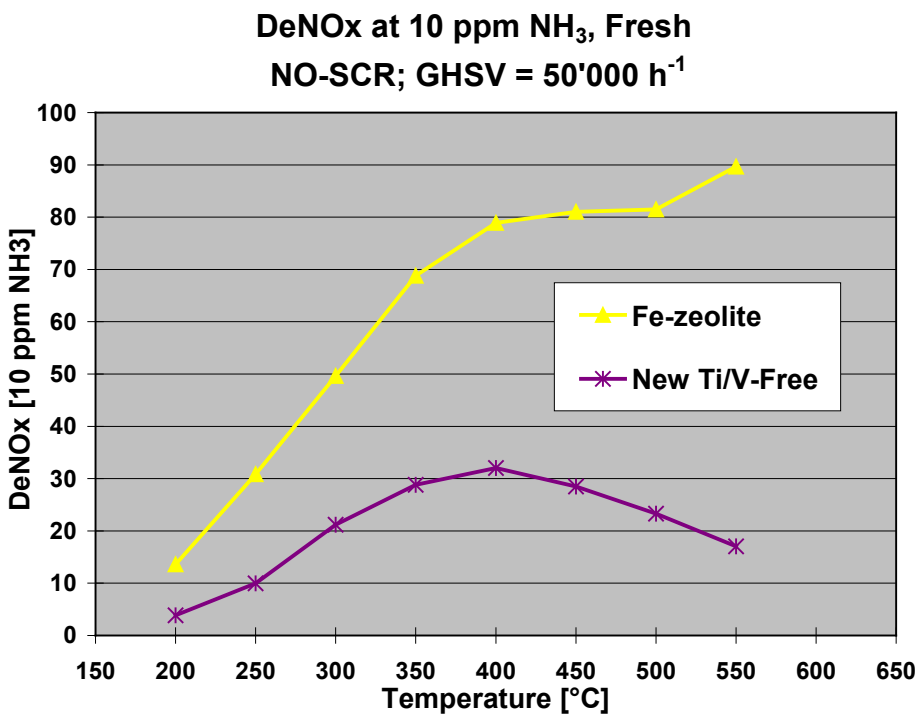


- New Ti/V* stability can be maintained

Evaluation of New Ti/V-Free- Activity

- Tests at Paul Scherrer Institute on wash-coated cordierite parts (including binder)

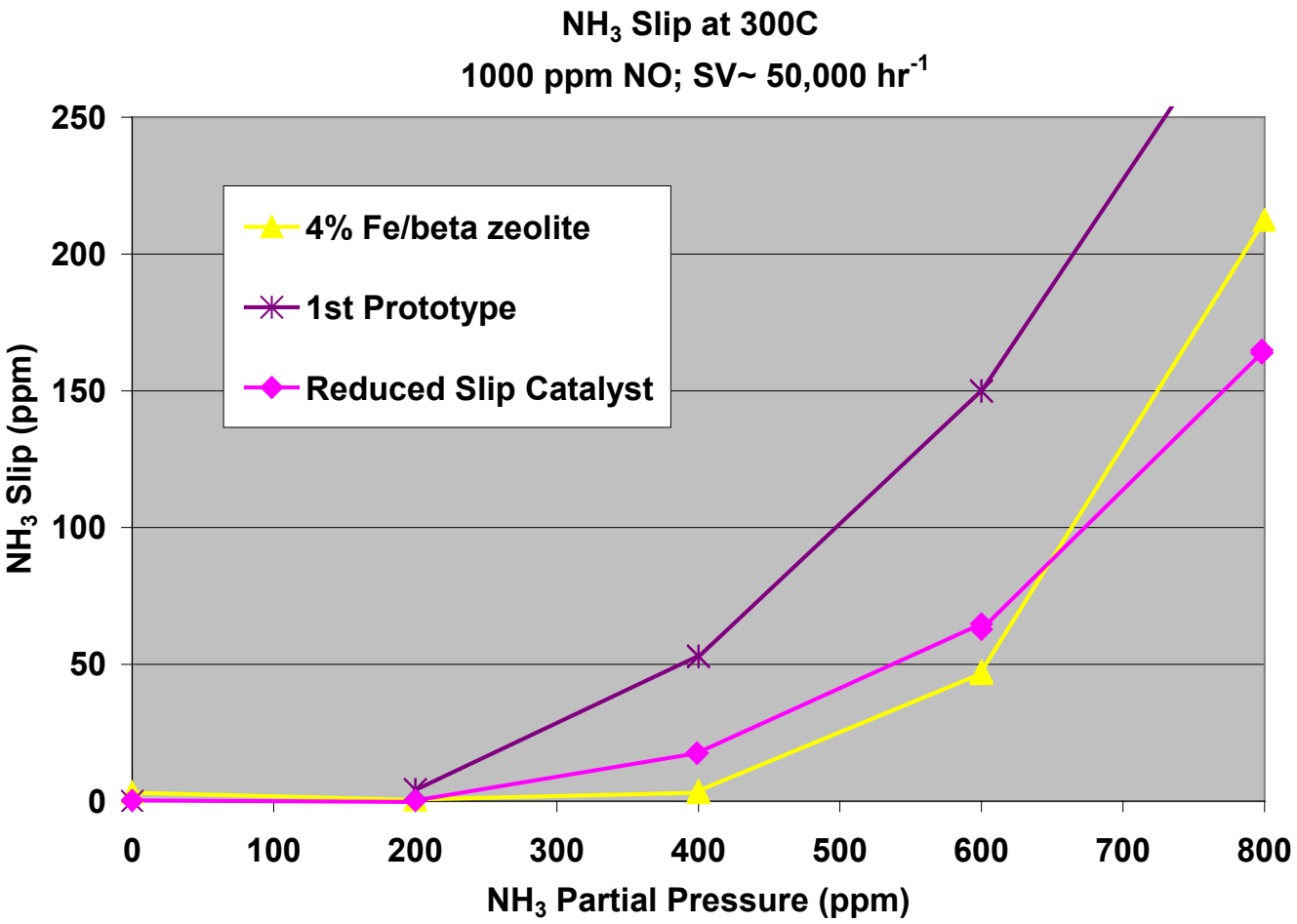




- New Ti/V-Free shows high ammonia slip vs. Fe-beta zeolite

New Ti/V-Free Refinements: NH_3 Slip

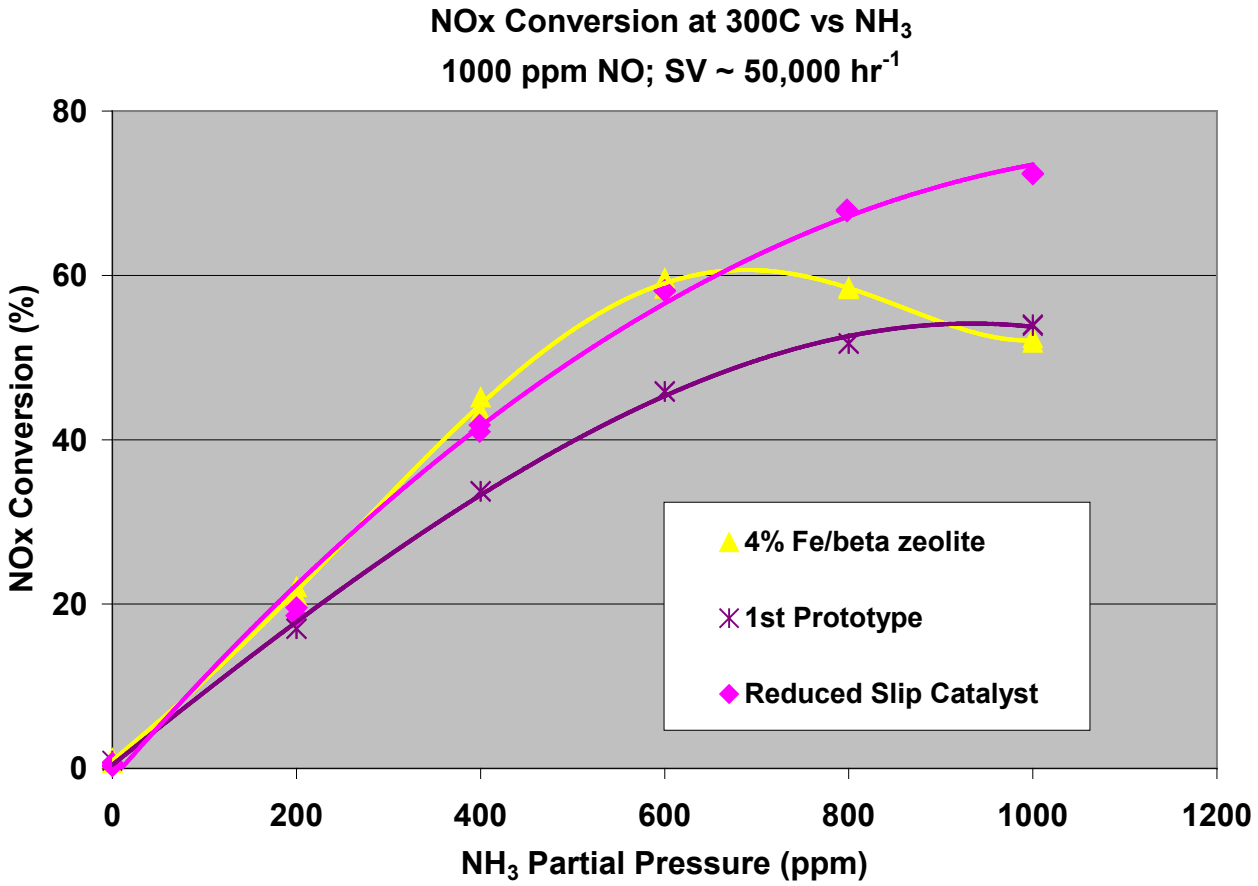
- Powder tests, varying NH_3/NO



- New Ti/V-Free ammonia slip can be improved

New Ti/V-Free Refinements- Activity

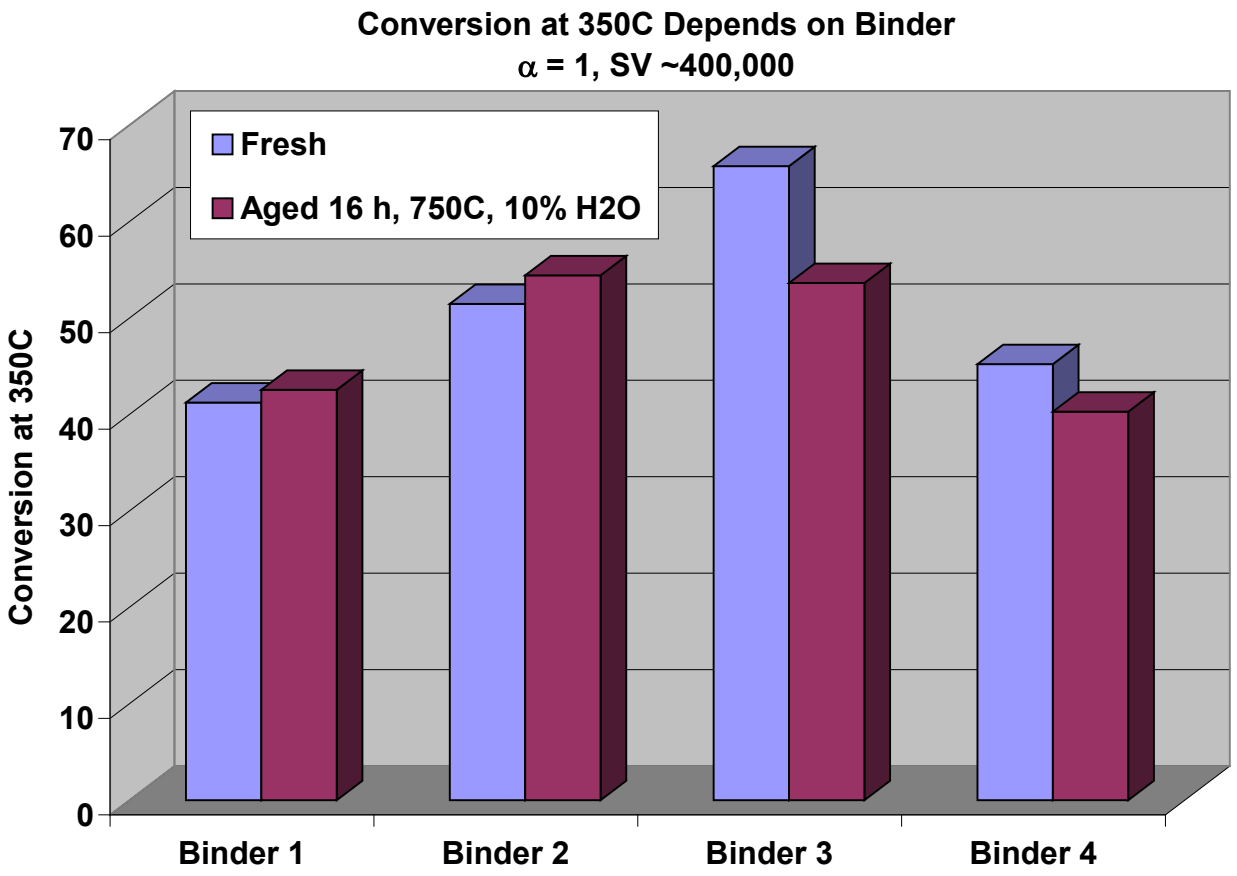
- Powder tests, varying NH_3/NO



- New Ti/V-Free fresh activity comparable to Fe-zeolite

New Ti/V-Free Refinements- Formulation

- Mixed powders with 10% “Binder”



- Formulation affects fresh and aged activity

Conclusions

System	Key Results
TiO_2 Substrate	• Can be stabilized in a controlled fashion via a new synthetic approach
New Ti/V	• First prototype designed for optimum aged activity • Supported phases (vanadia) can be stabilized • Low temperature activity can be improved to match best in class catalyst • System can be designed with necessary stability for full aged activity
New Ti/V-Free	• First prototype comparable to Fe-beta zeolite, but with high ammonia slip • Ammonia slip can be reduced to match reference • System can be designed for optimum fresh and aged activity
Catalyst + Binder	• Performance of formulated system depends on interactions between components

Thank-you!