Interdiffusion Behavior in Aluminide Coatings for Power Generation Applications

Y. Zhang
Tennessee Technological University

B. A. Pint
Oak Ridge National Laboratory

Key Issues Associated with Aluminide Coatings on Fe-based Substrates

- Iron aluminides have good high-temperature corrosion resistance in a variety of elevated-temperature environments (oxidizing, sulfidizing, carburizing)
- There are key issues that need to be addressed to achieve long oxidation lifetimes with aluminide coatings on iron-based substrates
  - CTE mismatch
  - Al backdiffusion (loss of Al to substrate)
- CVD aluminizing was used to form model coatings that are amenable to studying these key issues

The current research focus is on the interdiffusion behavior of aluminide coatings on Fe-9Cr-1Mo & 304L

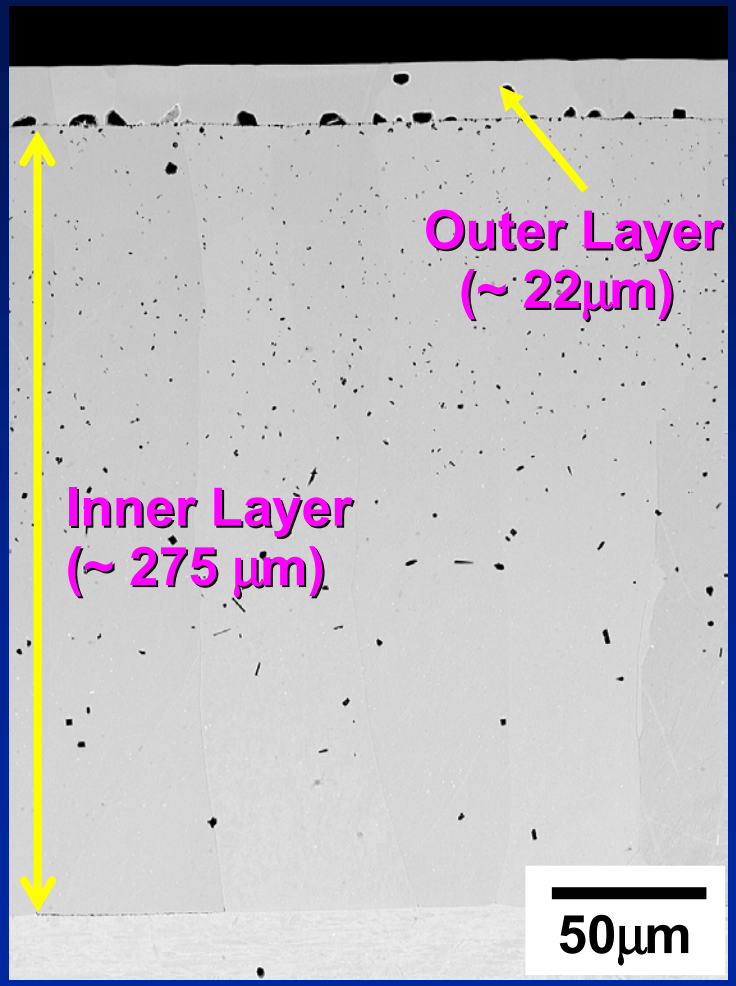
Diffusion tests: 2,000-10,000h at 500-800°C

Coating System	Diffusion Temperature (°C)	Diffusion Time (h)
CVD Aluminide Coatings on Fe-9Cr-1Mo and 304L	500	10,000 *
	600	5,000
		10,000 *
	700	2,000
		5,000
		10,000 *
	800	2,000

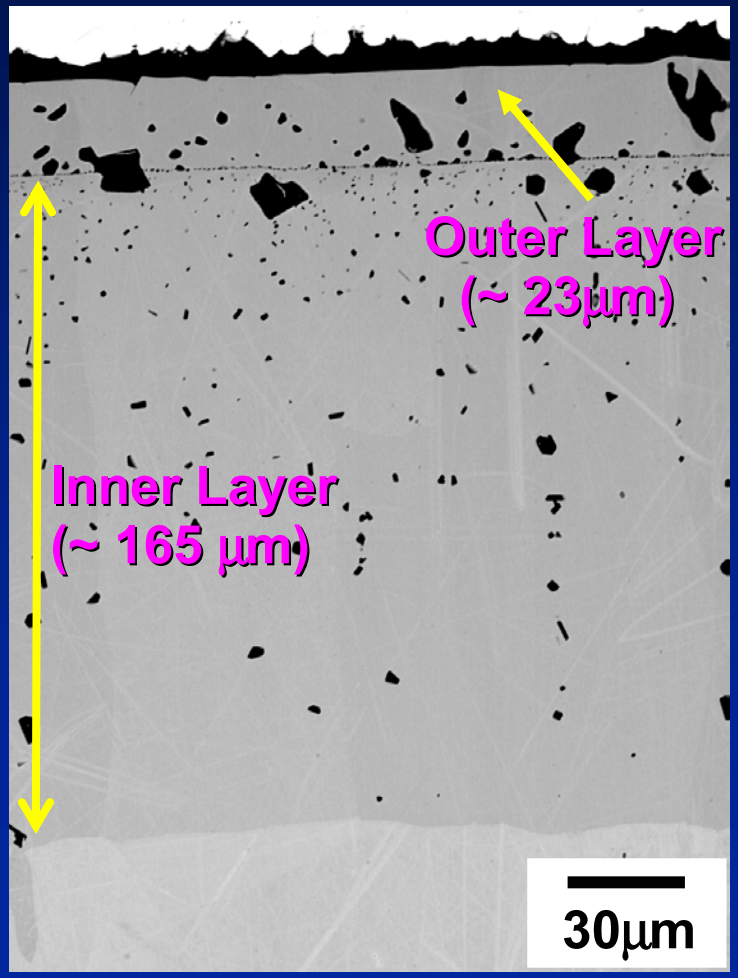
* Still in testing at the present time

CVD coating on steel substrates consisted of a thin Al-rich outer layer above a thick inner layer

As-coated, on Fe-9Cr-1Mo

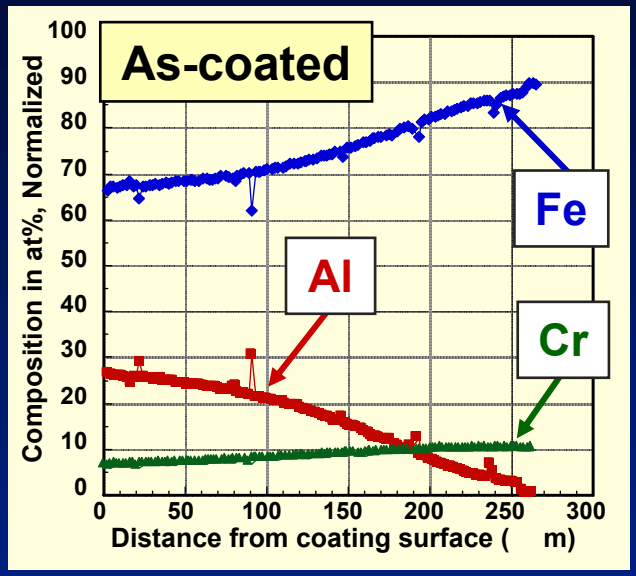


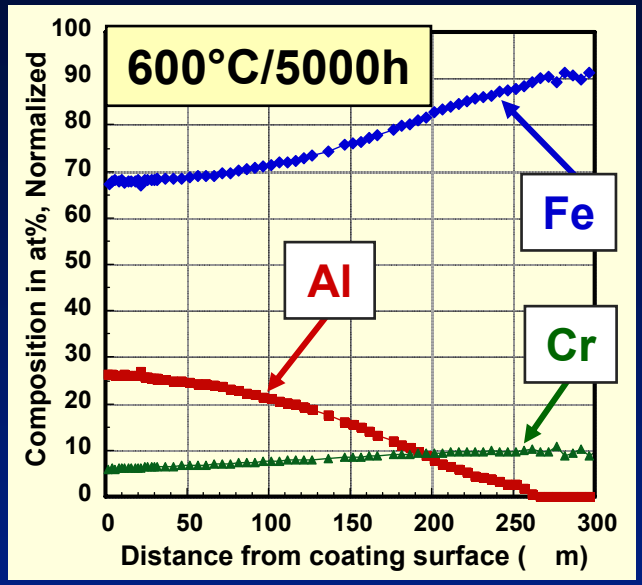
As-coated, on 304L



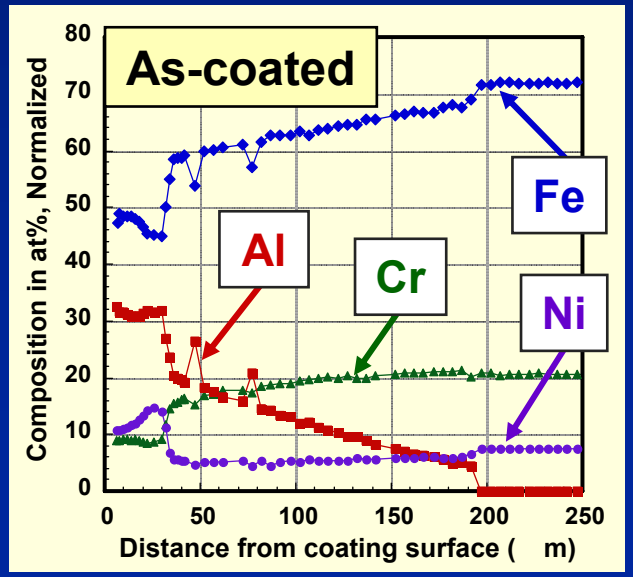
Negligible Interdiffusion at 600°C for 5000h

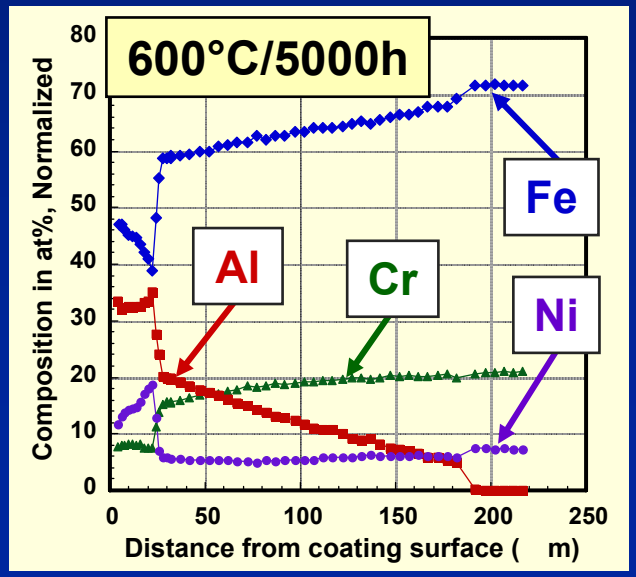
Coating on Fe-9Cr-1Mo





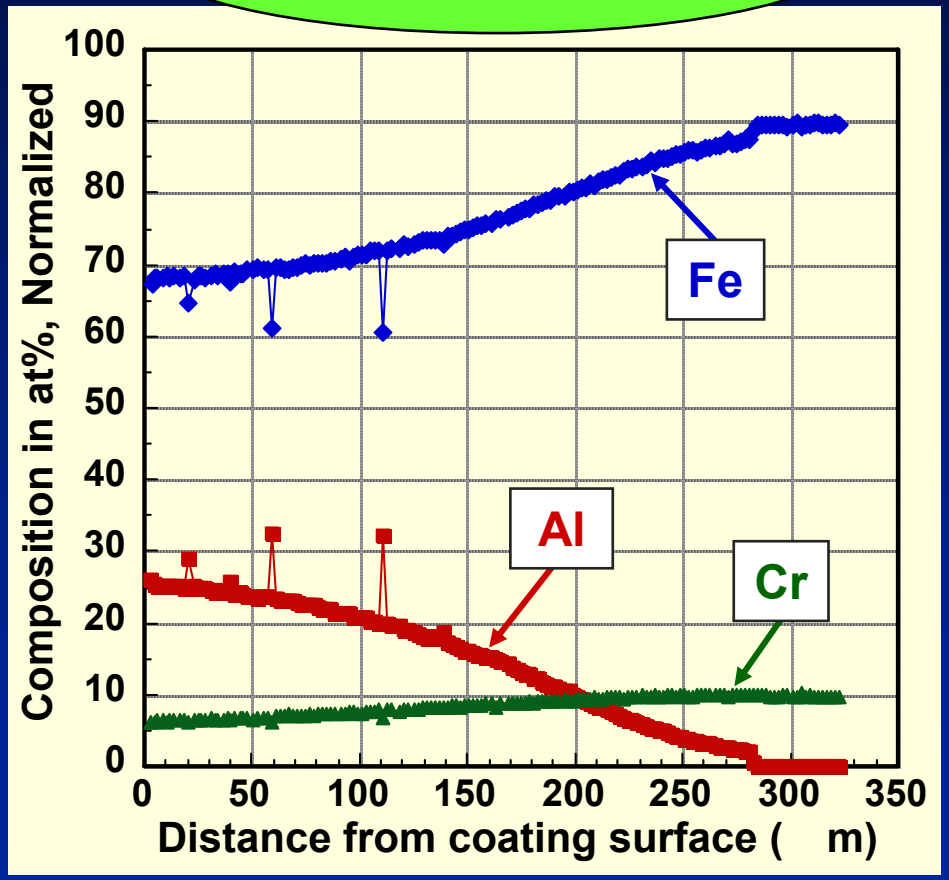
Coating on 304L



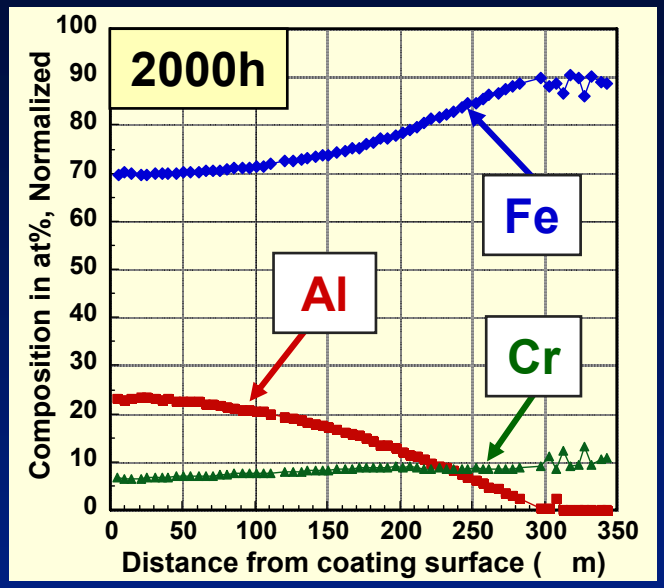


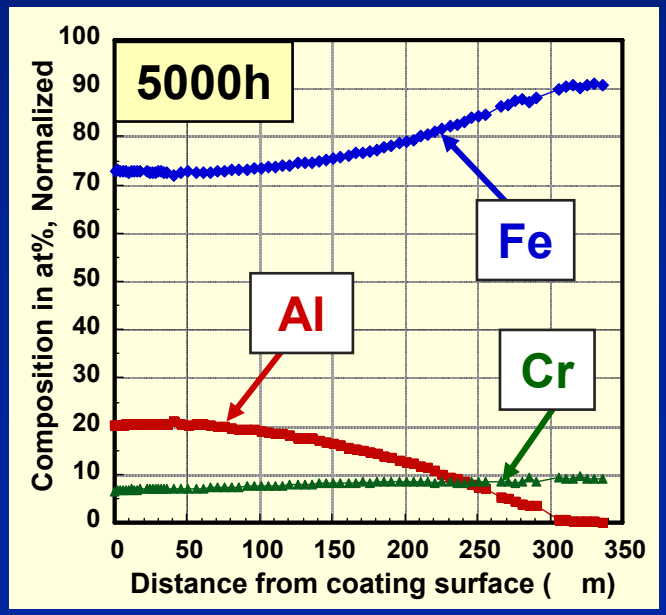
The decrease of Al at the coating surface was *not* significant on Fe-9Cr-1Mo at 700°C up to 5000h

Coating on Fe-9Cr-1Mo



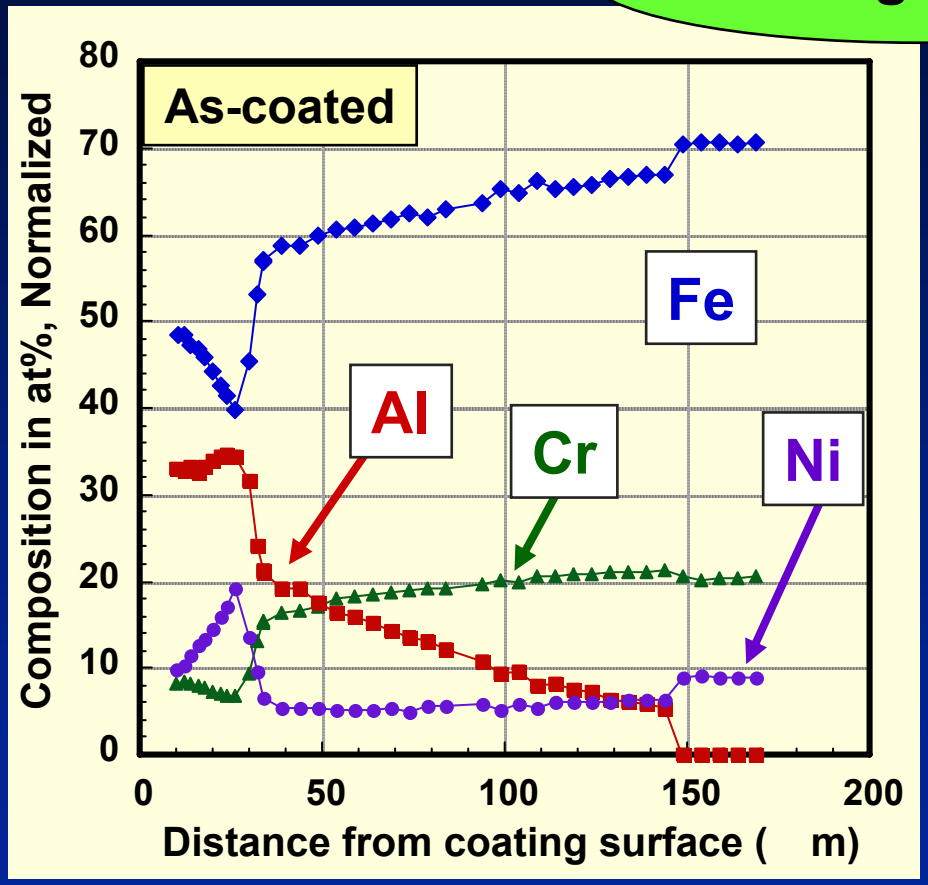
As-coated

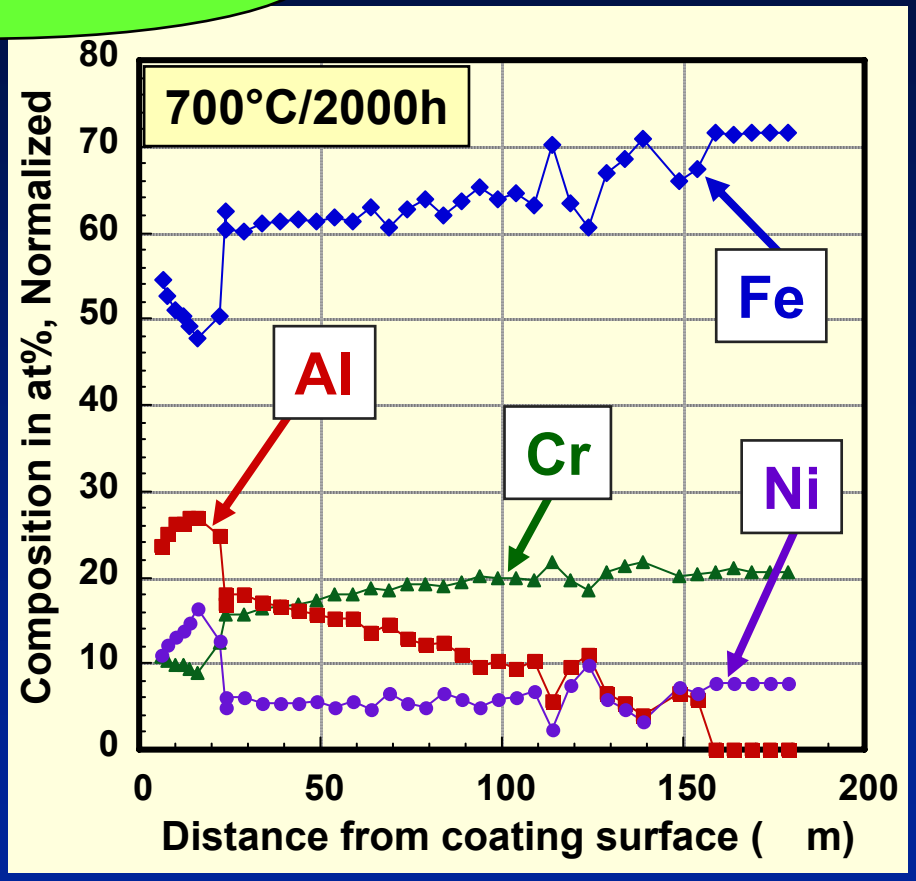




The Al content decreased at the coating surface on 304L at 700°C

Coating on 304L

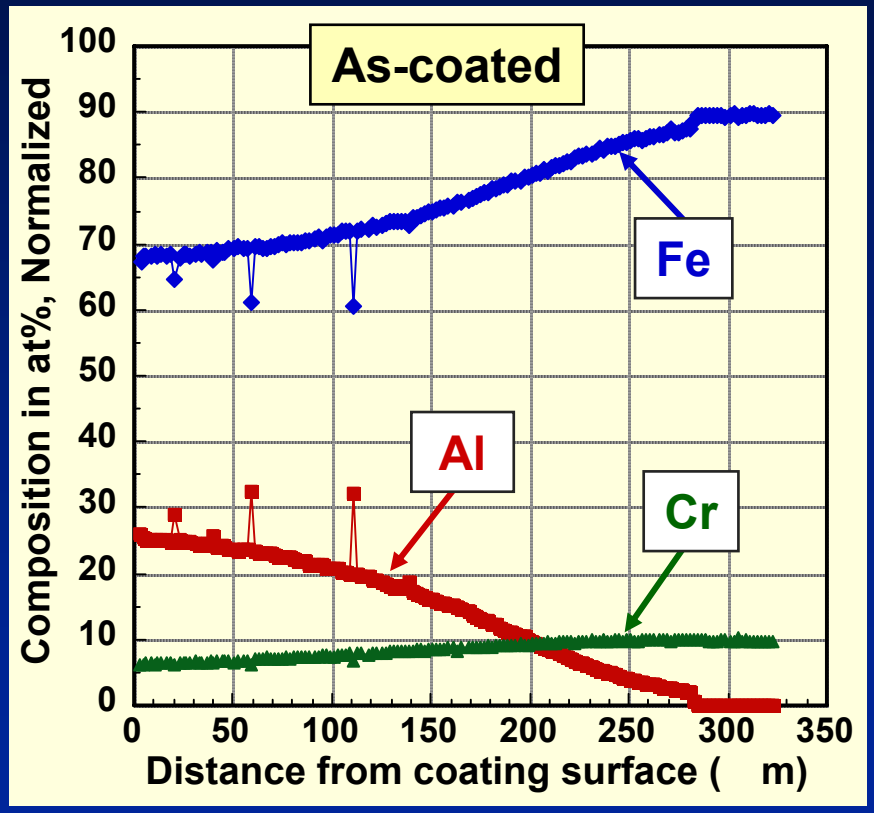


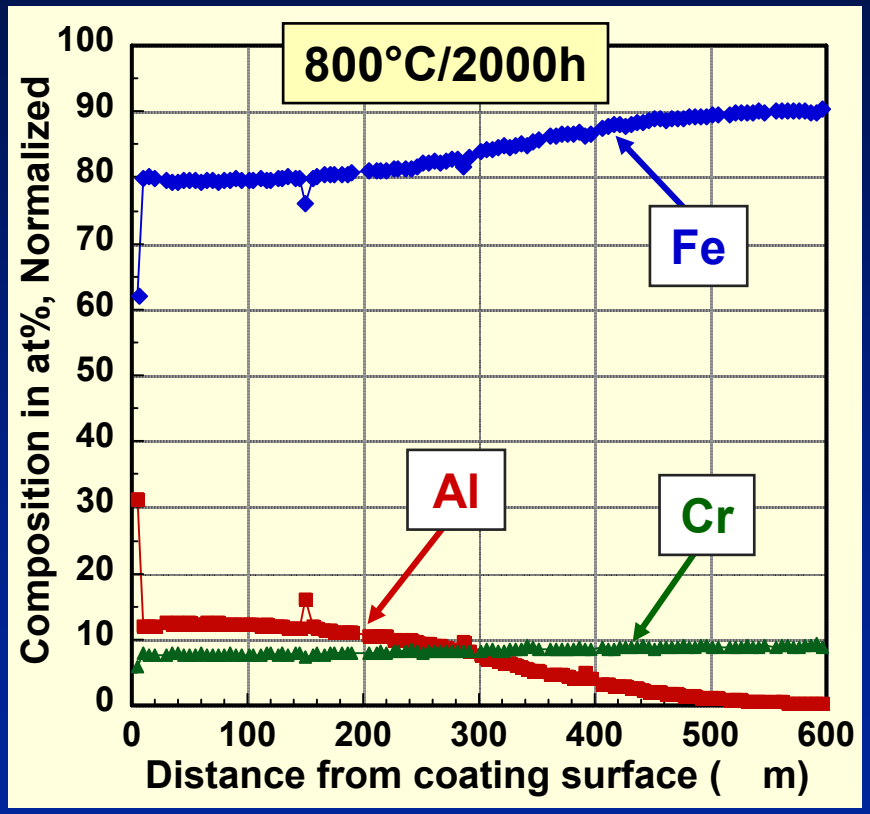


- The interdiffusion at 700°C led to decrease of Al from 34at% to 25at% at the coating surface after up to 5000h (only after 2000h is shown here)

Significant interdiffusion occurred between the coating and Fe-9Cr-1Mo at 800°C

Coating on Fe-9Cr-1Mo

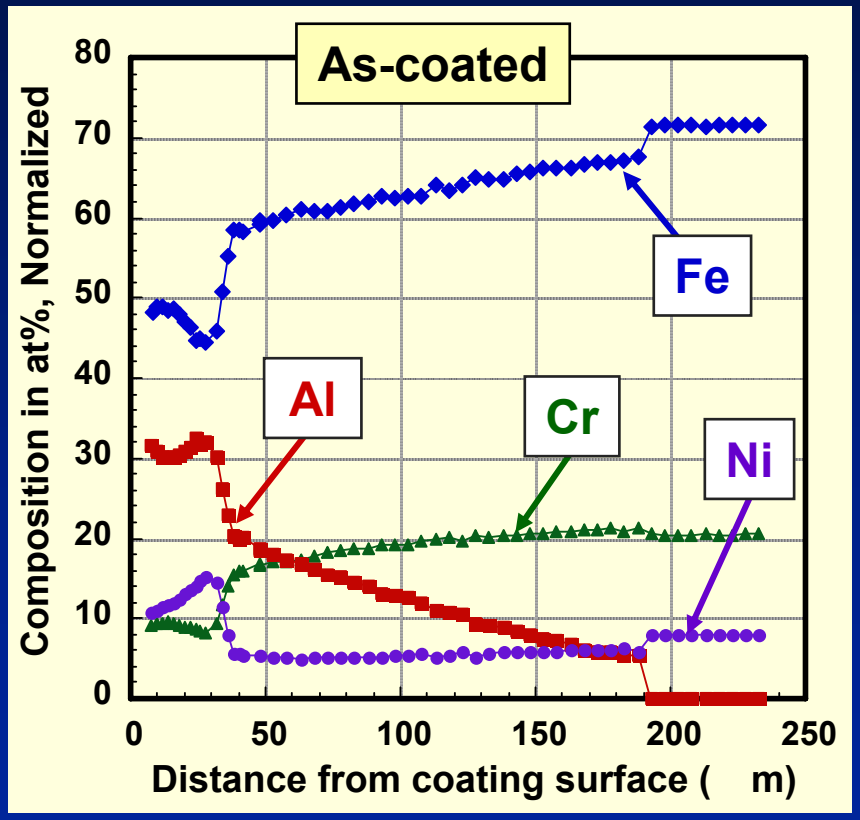


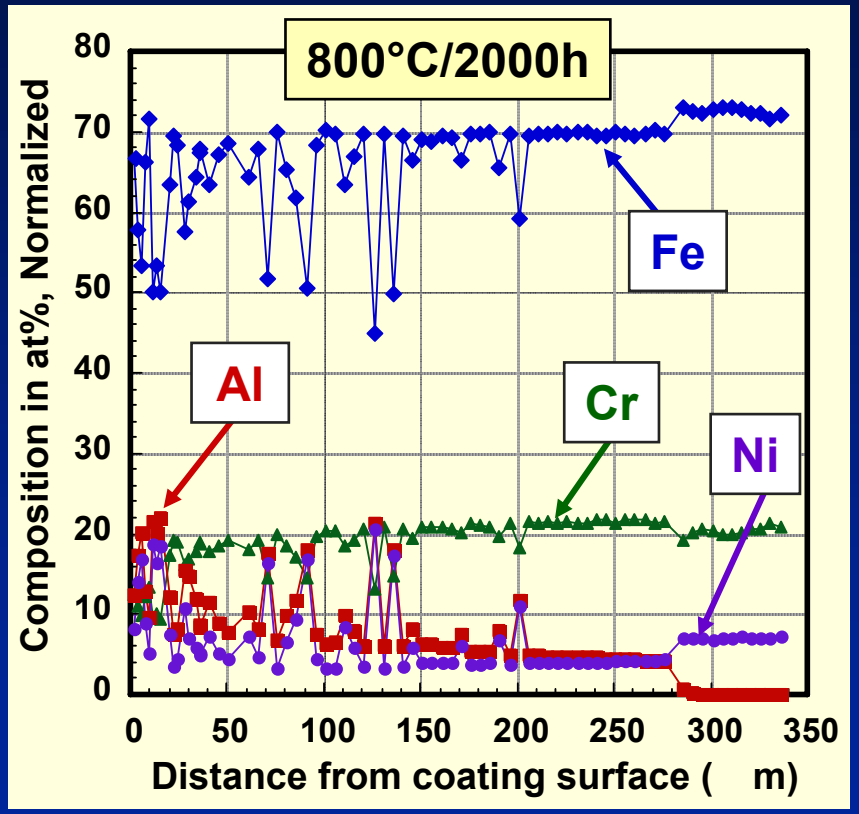


- The interdiffusion at 800°C caused decrease of Al from 25at% to 12at% at the coating surface after 2000h

Similar level of interdiffusion was observed between the coating and 304L at 800°C

Coating on 304L

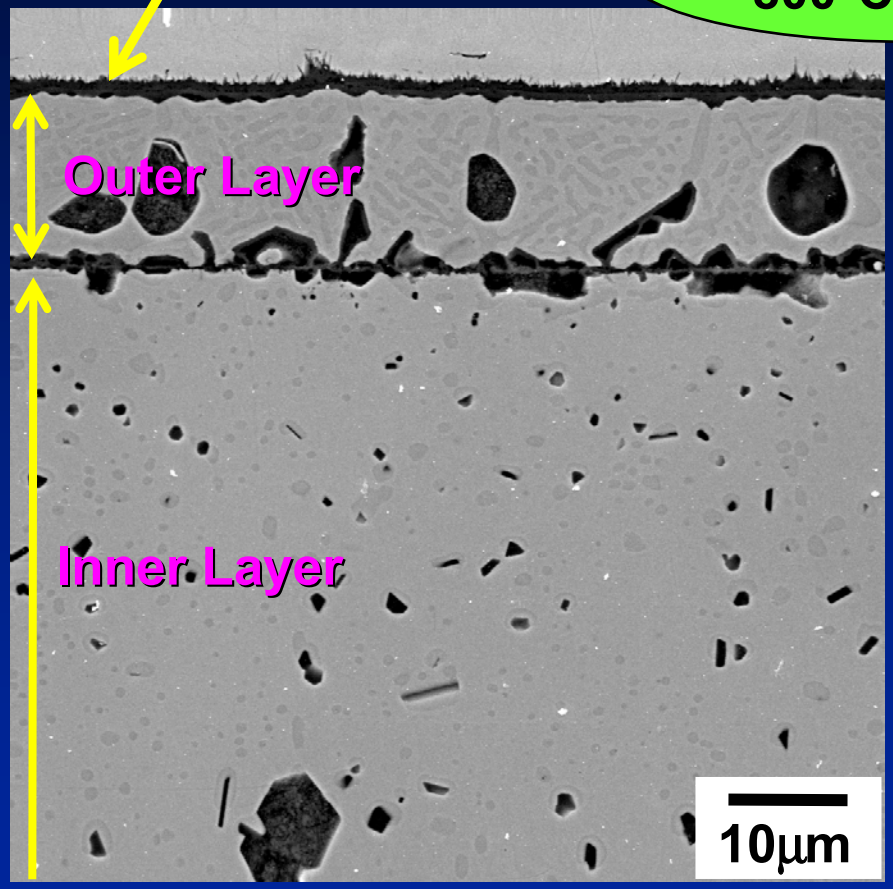


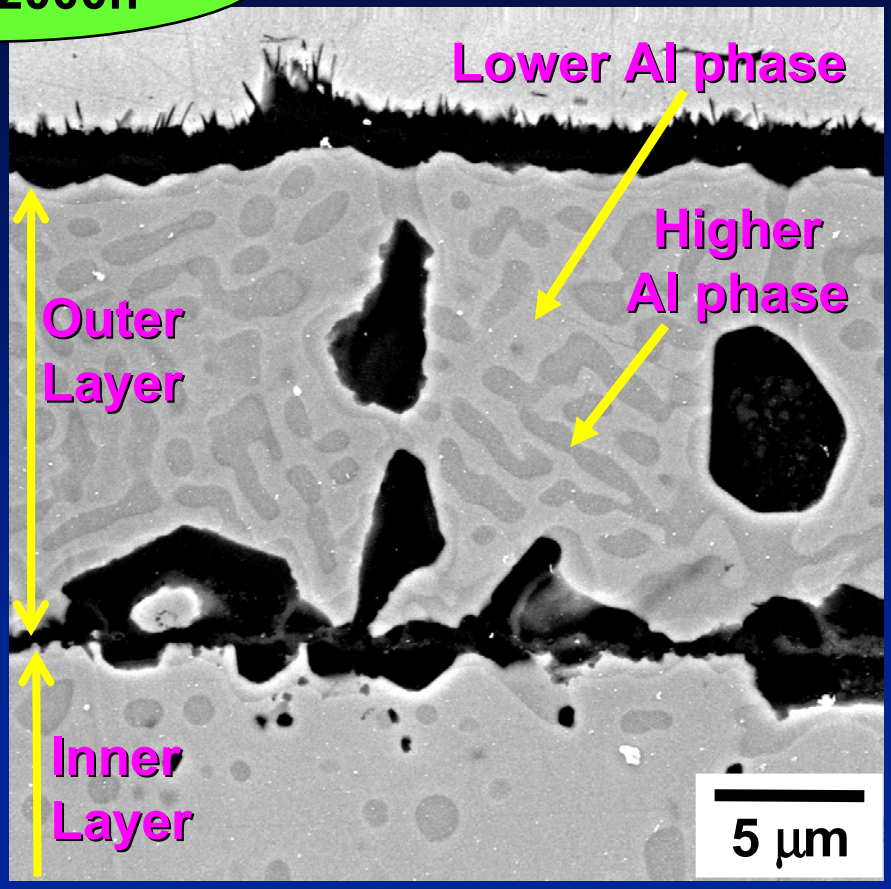


- The Al at the coating surface decreased from 32at% to 15-20 at% after 2000h at 800°C

Interdiffusion at 800°C resulted in the formation of a two-phase microstructure in the coating on 304L

Diffusion Test:
800°C/ 2000h





- The higher-Al phase (in at%): 40Al-40Ni-17Fe-3Cr
- The lower-Al phase (in at%): 9Al-4Ni-73Fe-14Cr

Summary

- The interdiffusion behavior between CVD aluminide coatings and ferritic and austenitic substrates is being studied for times up to 10,000h in the temperature range of 500-800°C
- The decrease of the Al content at the coating surface was not significant after extended diffusion times (≤ 5000h) at temperatures ≤ 700°C
- Interdiffusion at 800°C led to a significant decrease of Al and the formation of a two-phase microstructure in the outer layer of coating on 304L