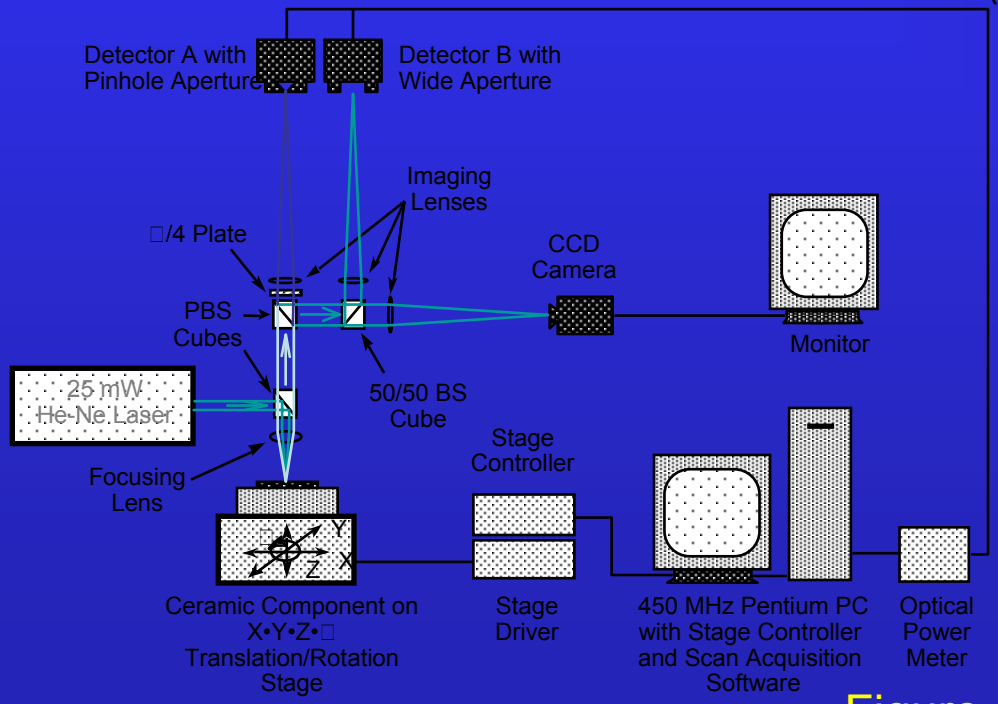
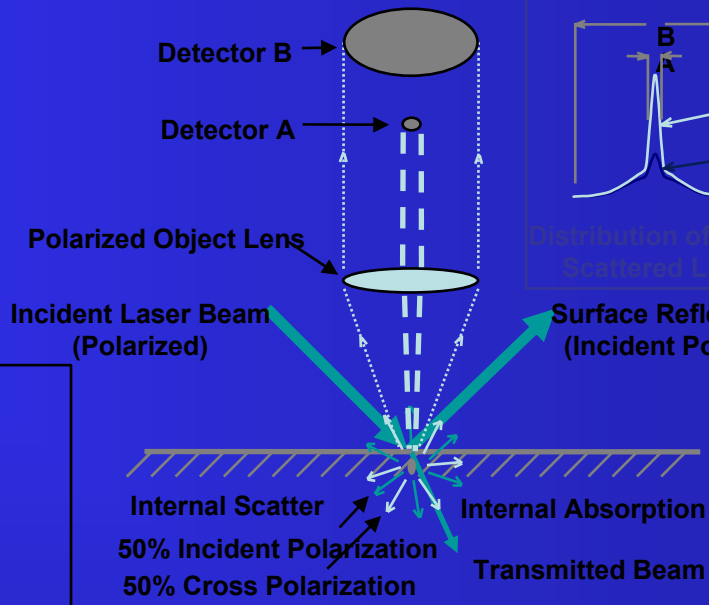
SCHEMATIC OF ELASTIC OPTICAL BACKSCATTER NDE EXPERIMENTAL TEST SETUP





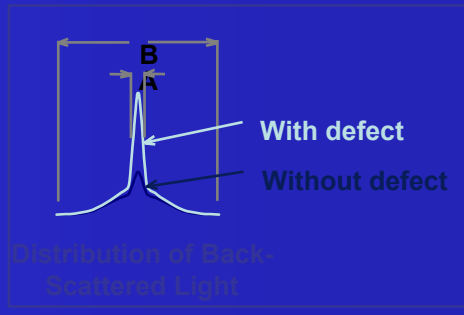


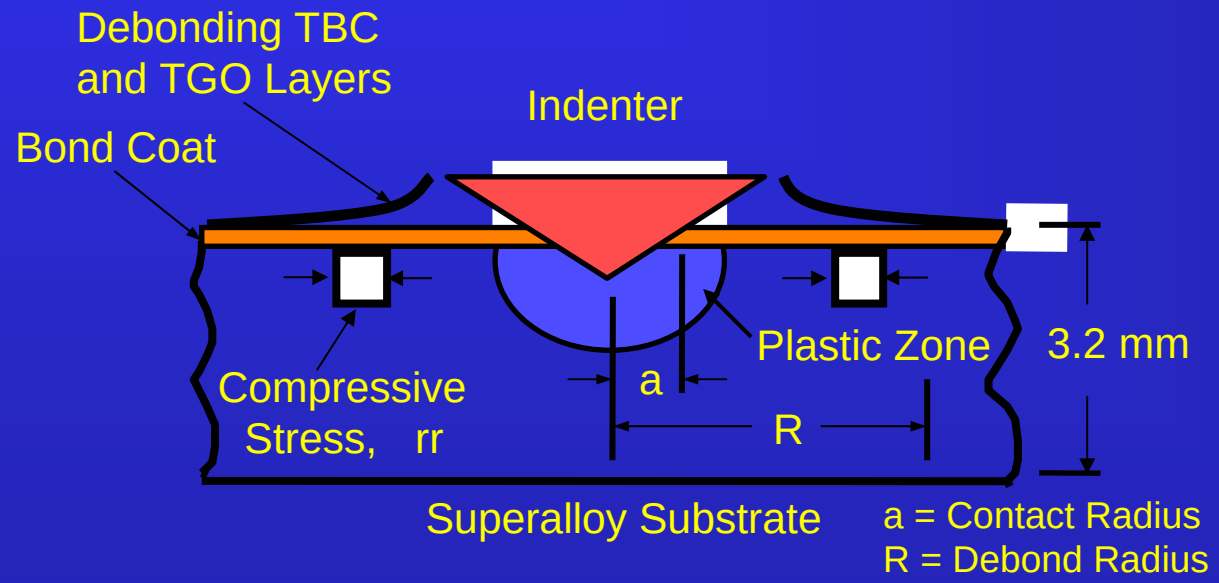
Figure 1

Explanatory Notes

Recent Correlations Between Data from ANL's Laser Back-Scatter NDE method and Indentation Test

Note: Tests are on YSZ TBC

Indentation Test for Interfacial Toughness



From G. Meier, Univ. of Pittsburgh

Figure 2

Explanatory Notes

University of Pittsburgh
EB-PVD
Sample 6A—170 Cycles, Sum Image
September 16, 2002

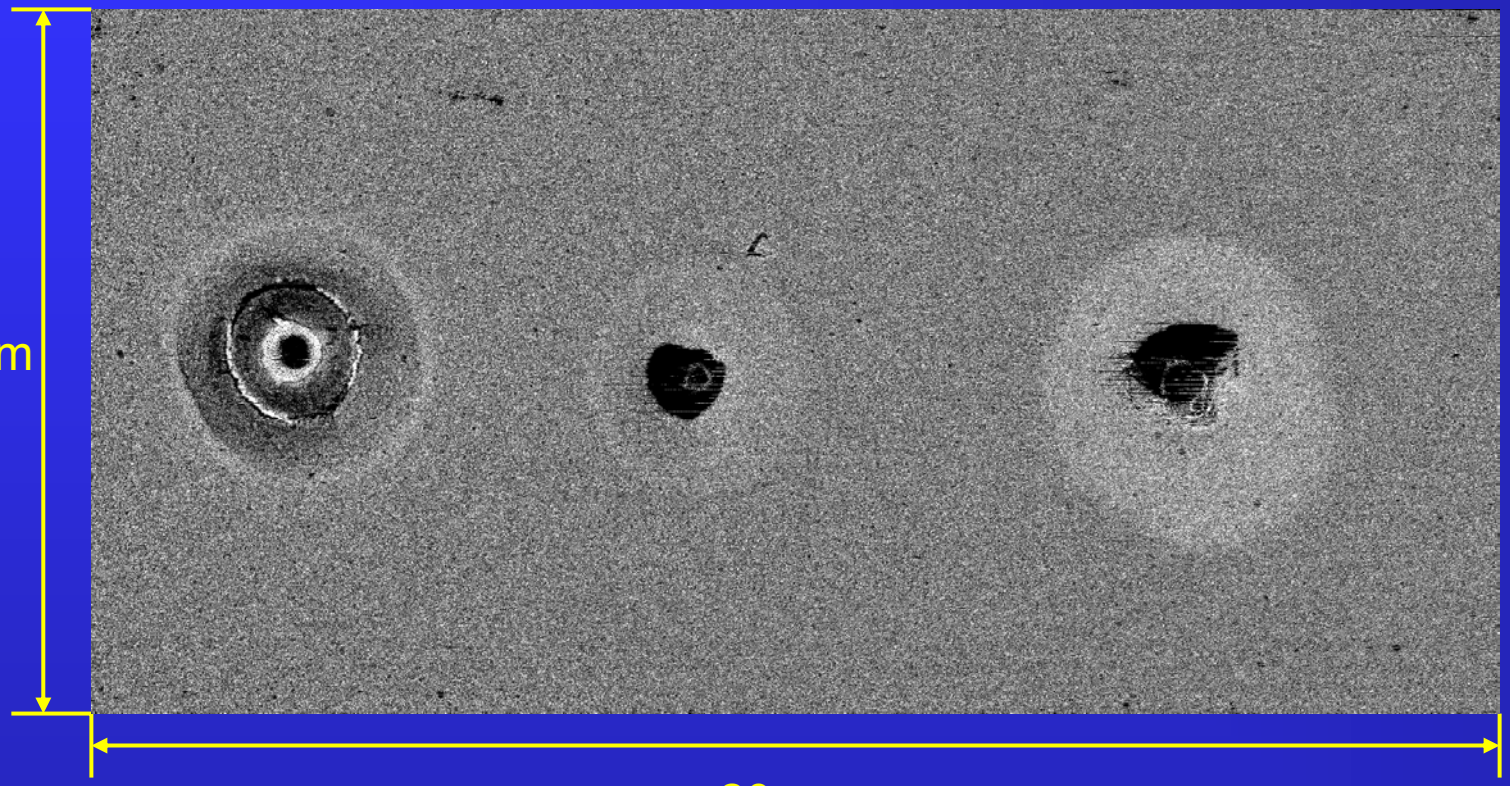


Figure 3

Explanatory Notes

University of Pittsburgh
EB-PVD
Sample 6A—170 Cycles, Ratio Image
September 16, 2002

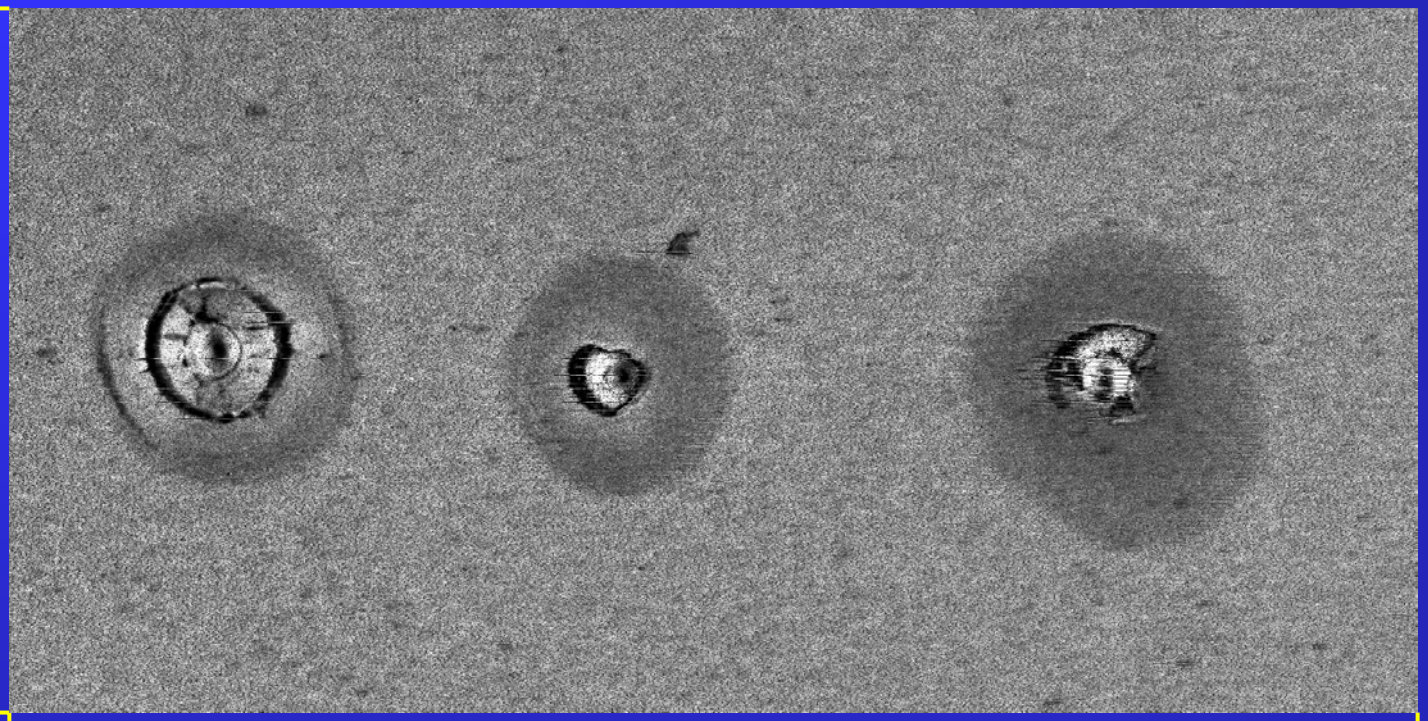


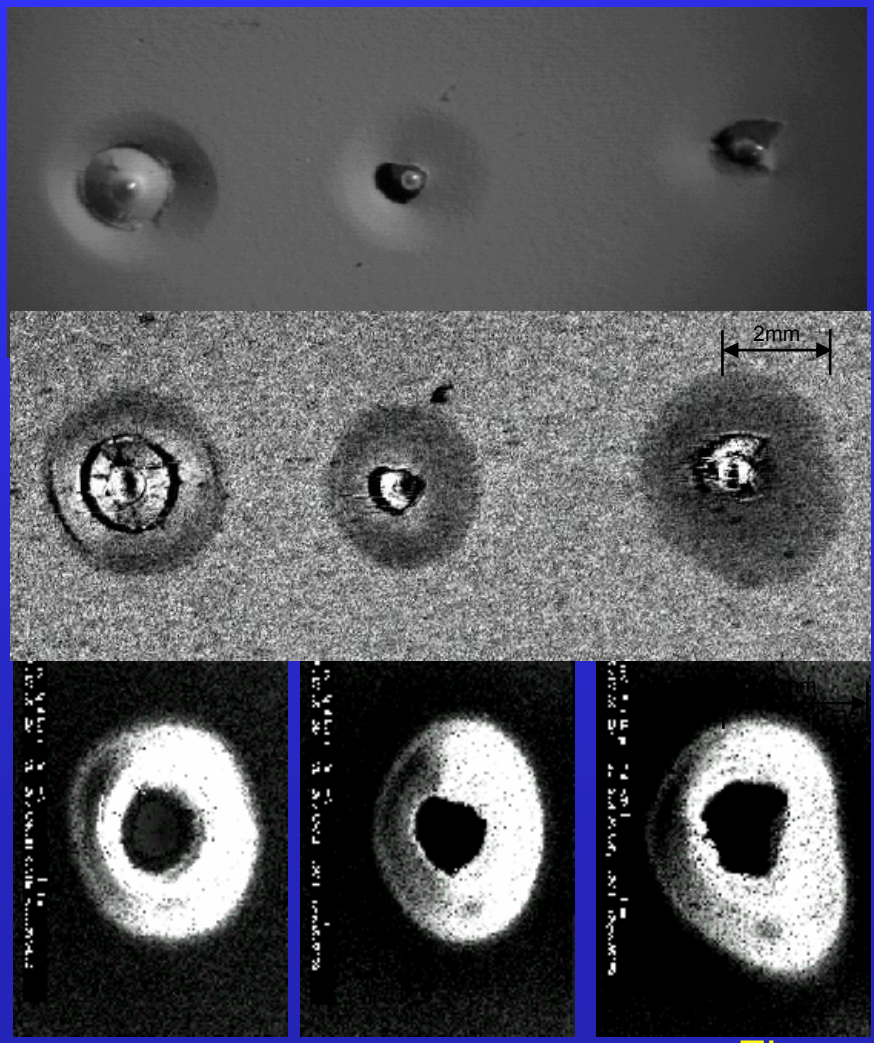
Figure 4

Explanatory Notes

Correlation of NDE Data with Optical Data

Note: These are for EB-PVD, YSZ, TBC

Initially indented after 50 cycles | Initially indented in as-processed condition | Indented after 170cycles



Optical Macrograph

Laser Scatter Image(debonds appear dark)

SEM Charging Image(debonds appear light)

Explanatory Notes

Cycles	R SEM (mm)	R Backscatter (mm)	% Diff
0	1.39	1.40	0.7
50	1.60	1.66	3.8
170	1.74	1.82	4.6

From G. Meier, Univ. of Pittsburgh

Figure 5

EXPLANATORY NOTES

- **Schematic of Elastic Optical Backscatter NDE Experimental Test Setup -** The figure in the lower left corner shows our experimental setup for acquiring data with the laser backscatter technique. Half of the laser light is reflected normal to the sample by the first beam-splitting cube. The light reflected and scattered from the sample is then collected using the other two beam-splitting cubes. Two images are generated. One image is a sum of the voltages measured by the two detectors, while the other image is the ratio of those two values. The distribution of the backscattered light with and without a defect is represented by the figure in the upper right corner.

- **Recent Correlations Between Data from ANL's Laser Back-Scatter NDE method and Indentation Test -** This slide outlines the cooperative enough with the University of Pittsburgh. They have prepared several TBC samples and subjected them to intentional damage as indicated by the process shown on this slide. This creates a "debond" region around the indent. The samples have been scanned with the laser backscatter technique using a 633 nm Helium Neon laser. At the time this data was acquired, the sample had been subjected to 170 thermal cycles (one cycles consists of 45 minutes at a high temperature, followed by 15 minutes at room temperature). The two images obtained are shown on the next two slides.

- **University of Pittsburgh, EB-PVD, Sample 6A—170 Cycles, Sum Image, September 16, 2002 -** This slide shows the "sum" image (i.e. measurement of the sum of the two detector outputs) from the laser backscatter scan of the sample designated 6A. The three "defects" in the image are the intentional indents created by the University of Pittsburgh. The "debond" region around each indent appears brighter (i.e. more white in color) while the actual indent appears dark. The scan is of a region 20 mm X 10 mm. Each pixel represents an area 10 um by 10 um.

- **University of Pittsburgh, EB-PVD, Sample 6A—170 Cycles, Ratio Image, September 16, 2002 -** This is the "ratio" image (i.e. the ratio of the two detector measurements) obtained from the scan of the sample described above. Notice on this image that the debond regions appear darker. Also note the amount of detail visible at the location of each indent. The dimensions for this image are identical to those for the "sum" image.

- **Correlation of NDE Data with Optical Data -** This slide shows a comparison between an optical micrograph, laser backscatter "ratio" image and SEM charging Image of Sample 6A after it had been subjected to 170 thermal cycles. The chart in the lower right corner compares the size of each debond region as measured from the SEM Charging data and the laser backscatter data. (Note: Each of the indents was made after a different number of thermal cycles as indicated on the slide.) The laser backscatter image is also correlated with the optical micrograph—note the indent on the far left side of the image.