

LA-UR-15-24064

Approved for public release; distribution is unlimited.

Title: Summary of Results from First Experiment on Multi-Crystal Titanium Sample

Author(s): Rigg, Paulo A.
Cerreta, Ellen Kathleen

Intended for: Release to an author who has left the Laboratory

Issued: 2015-06-02

Disclaimer:

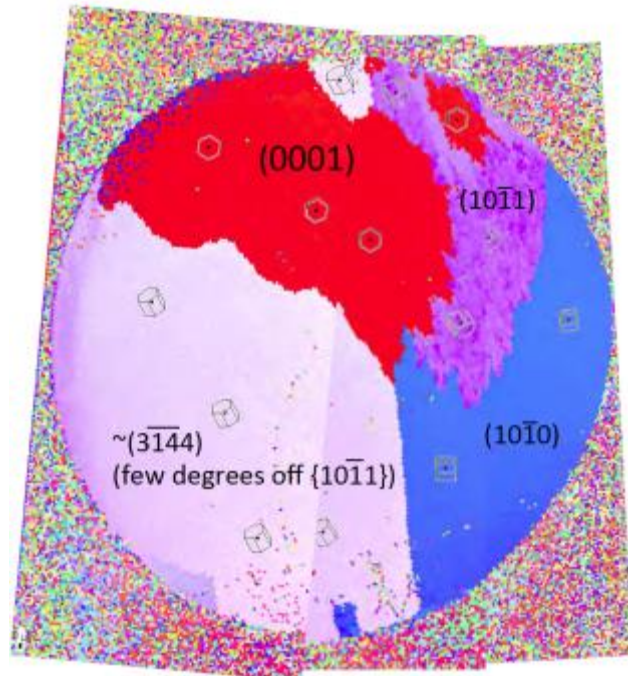
Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Summary of Results from First Experiment on Multi-Crystal Titanium Sample

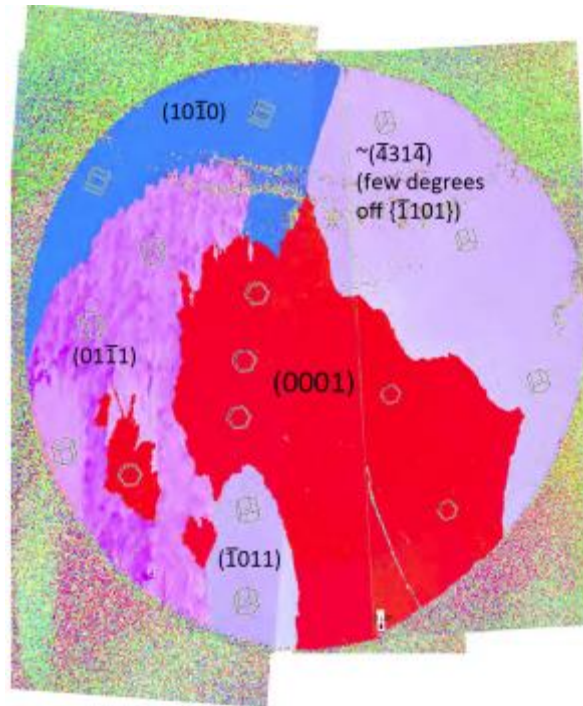
Paulo Rigg and Ellen Cerreta

Three samples were sliced from a large-grain Ti sample

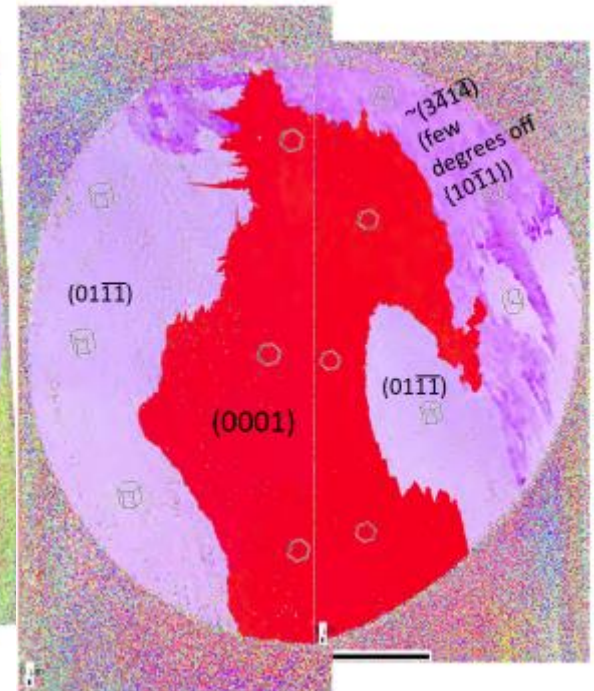
Sample A



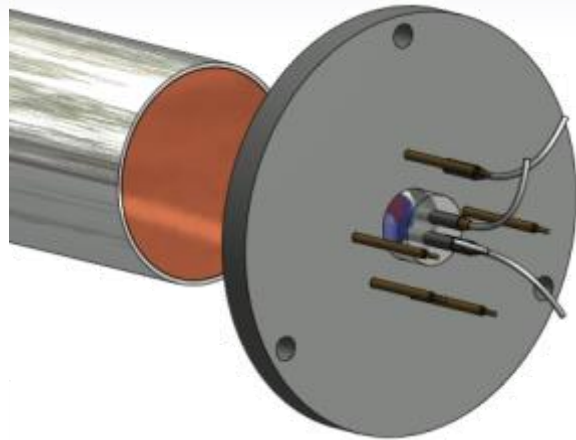
Sample B



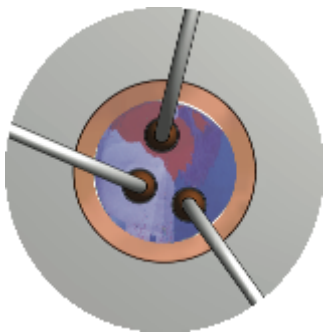
Sample C



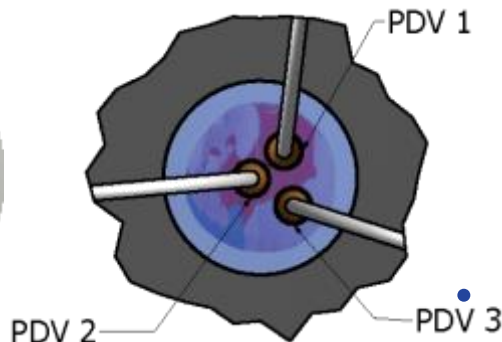
Performed two plate impact experiments to look for α to ω transition in multi-grain Ti samples.



- Copper impactor used to generate shock in multi-crystal Ti sample.
- PDV probes were positioned to obtain the particle velocity at the free surface from a single grain.
- PZT pins were used to determine impact time.
- Cross-timing between pins and PDV were used to roughly determine the shock velocity.
 - Difficult to do cross-timing accurately.
 - Shock velocities should be verified independently in the future.
- Hugoniot points (stress, density, and particle velocity) were determined using impedance matching and the Jump Conditions.



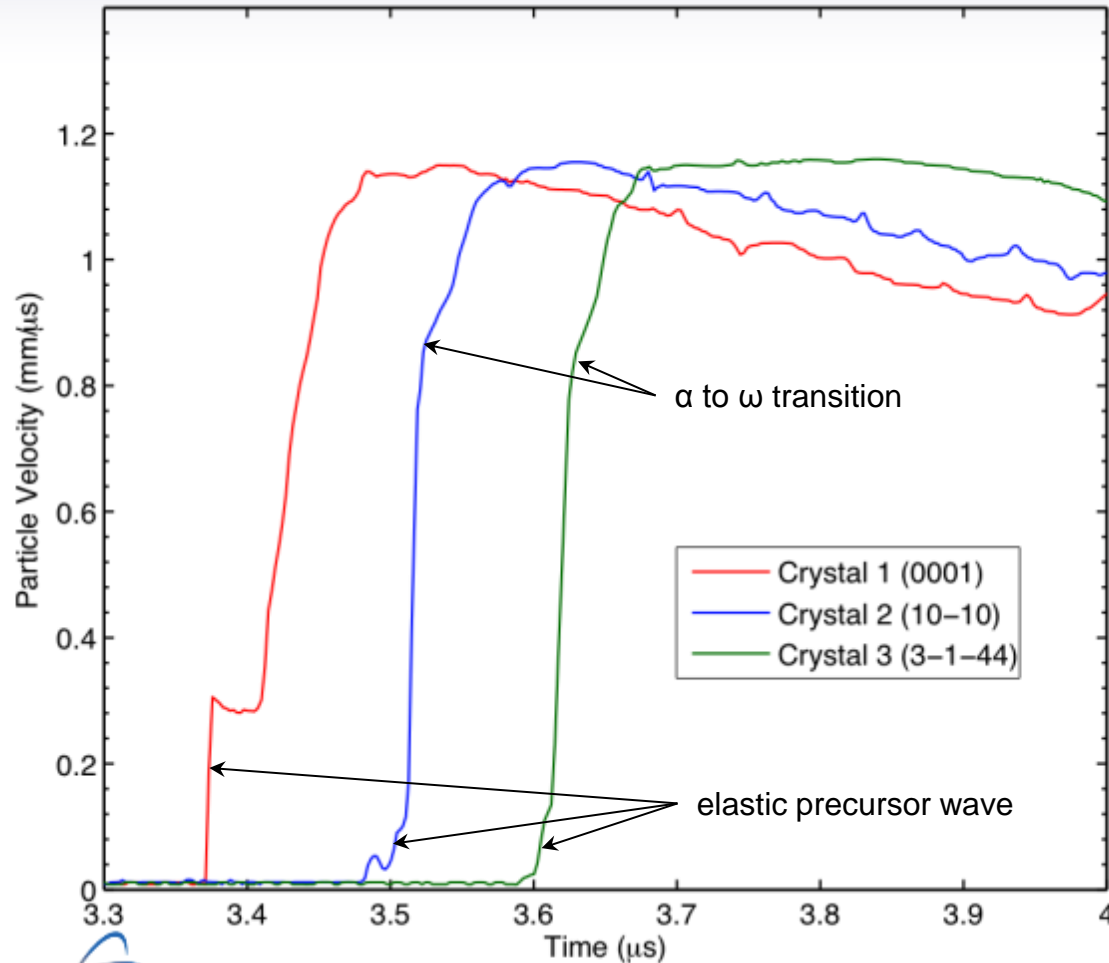
Shot 1



Shot 2

Wave Profiles from Experiment 1

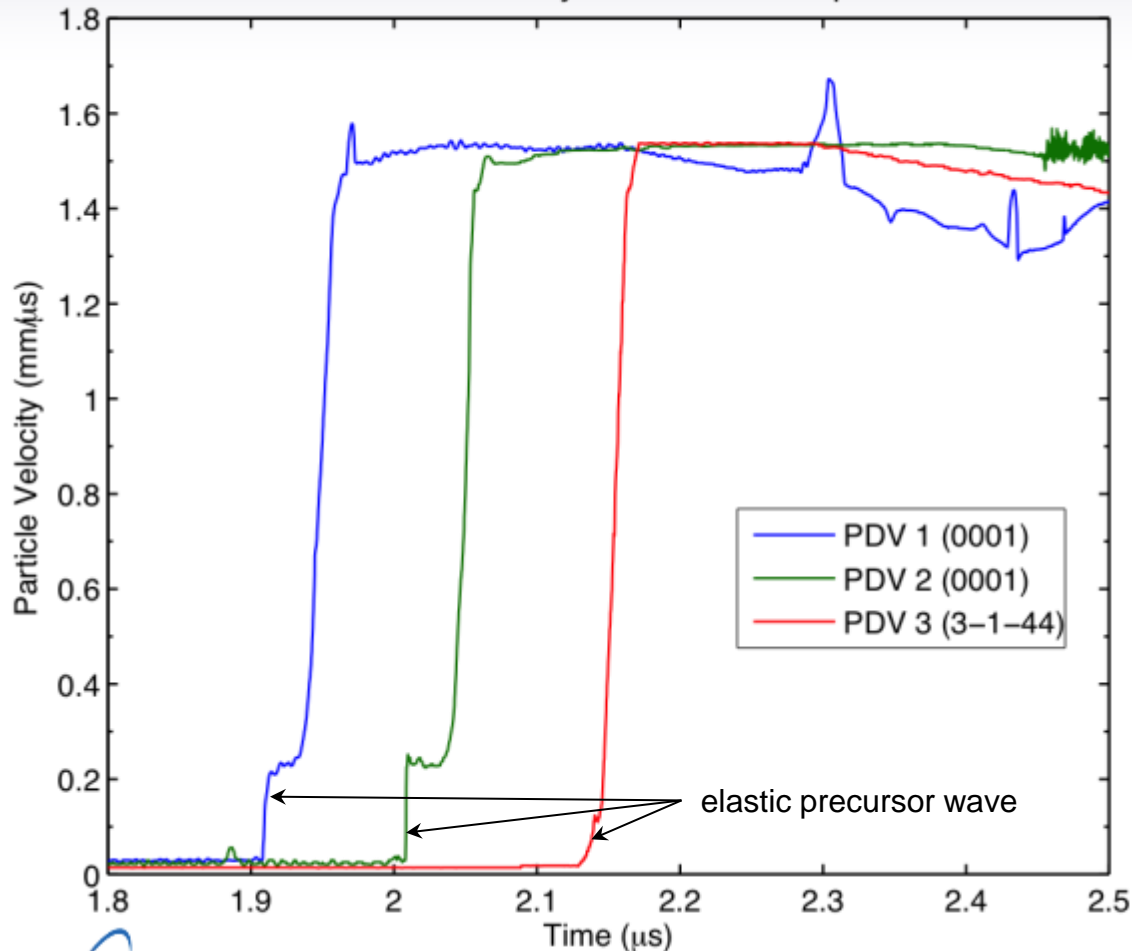
Results from Multi-Crystal Titanium



- α to ω transition observed in 2 orientations at ~ 11 GPa.
 - Consistent with pure and A70 polycrystalline Ti.
- Very high elastic precursor observed along (0001) direction.
- α to ω transition in (0001) direction likely occurs at a higher stress.
 - How much higher??

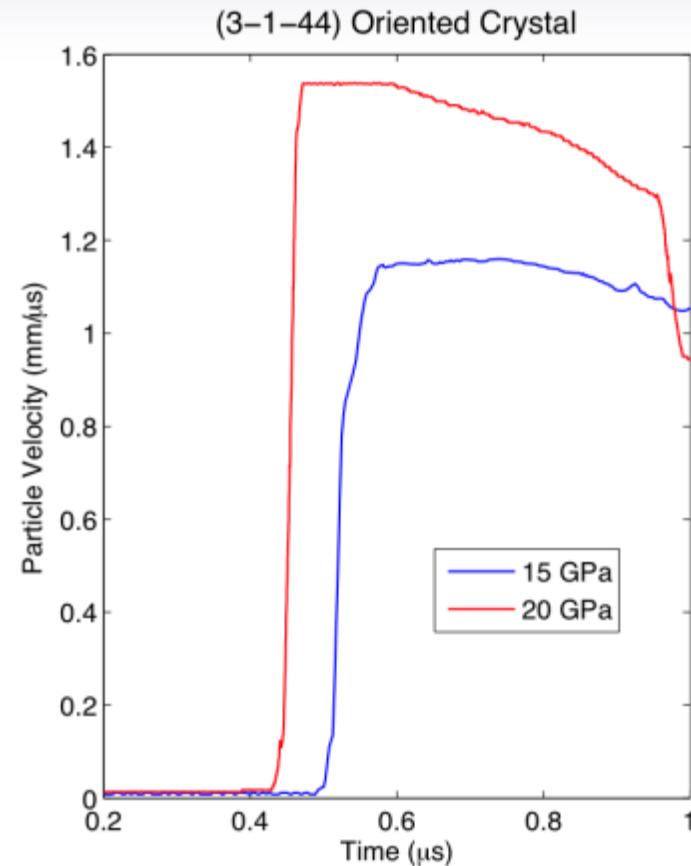
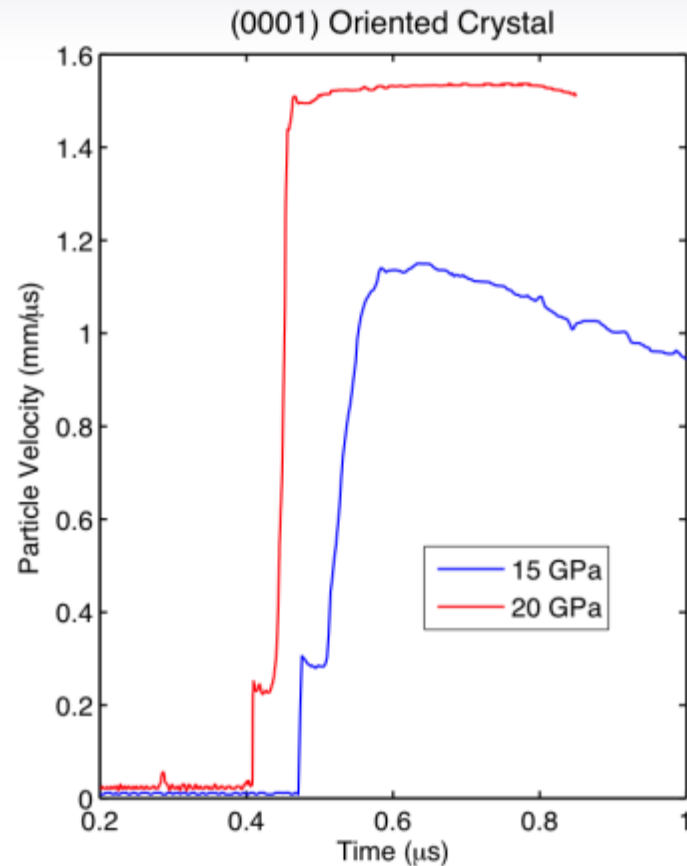
Wave Profiles from Experiment 2

Results from Multi-Crystal Titanium Experiment 2



- No three wave structure observed
- High elastic precursor again observed along (0001) direction.

Comparison of Two Experiments



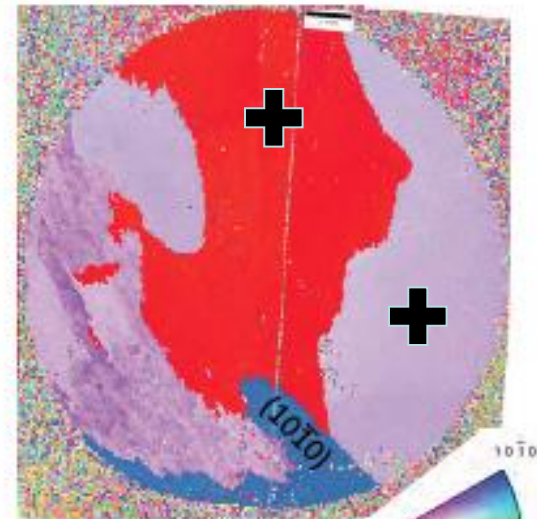
Longitudinal sound speed measurements (J. P. Escobedo-Diaz)

Long. Sound speed (mm/ μ s)		
Orientation	Sample B	Sample C
Red grain +	$6.352 \pm .012$	$6.359 \pm .015$
Purple grain +	$6.041 \pm .009$	$6.096 \pm .026$

FYI: The reported
 C_L for poly Ti is
 $6.07\text{mm}/\mu\text{s}$



B



C

Estimated Hugoniot parameters from each grain

Hugoniot Parameters	Crystal Orientation		
	(0001)	(10 $\bar{1}0$)	(3 $\bar{1}44$)
U_S^{EL} (mm/ μ s)	6.44 ± 0.06	5.80 ± 0.05	5.78 ± 0.05
u_P^{EL} (mm/ μ s)	0.210 ± 0.008	0.048 ± 0.005	0.048 ± 0.005
P^{EL} (GPa)	6.1 ± 0.2	1.3 ± 0.1	1.2 ± 0.1
ρ^{EL} (g/cm ³)	4.679 ± 0.008	4.564 ± 0.006	4.564 ± 0.006
U_S^{α} (mm/ μ s)	5.1 ± 0.2	5.5 ± 0.2	5.5 ± 0.2
u_P^{α} (mm/ μ s)	0.585 ± 0.005	0.43 ± 0.02	0.43 ± 0.02
P^{α} (GPa)	14.9 ± 0.2	10.9 ± 0.5	10.8 ± 0.5
ρ^{α} (g/cm ³)	5.06 ± 0.02	4.91 ± 0.02	4.91 ± 0.02
U_S^{ω} (mm/ μ s)	—	4.9 ± 0.2	4.9 ± 0.2
u_P^{ω} (mm/ μ s)	—	0.594 ± 0.006	0.596 ± 0.006
P^{ω} (GPa)	—	14.5 ± 0.3	14.4 ± 0.3
ρ^{ω} (g/cm ³)	—	5.09 ± 0.02	5.10 ± 0.02

Comparison of Results to Marsh Data

