



Burning of CP Titanium (Grade 2) in Oxygen-Enriched Atmospheres

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Background

- Titanium parts can be exposed to conditions which by virtue of the high pressure conditions could be considered oxygen –enriched
- To assist in a failure analysis of such a scenario the flammability of Ti as a function of sample diameter, test gas pressure, and oxygen concentration was evaluated

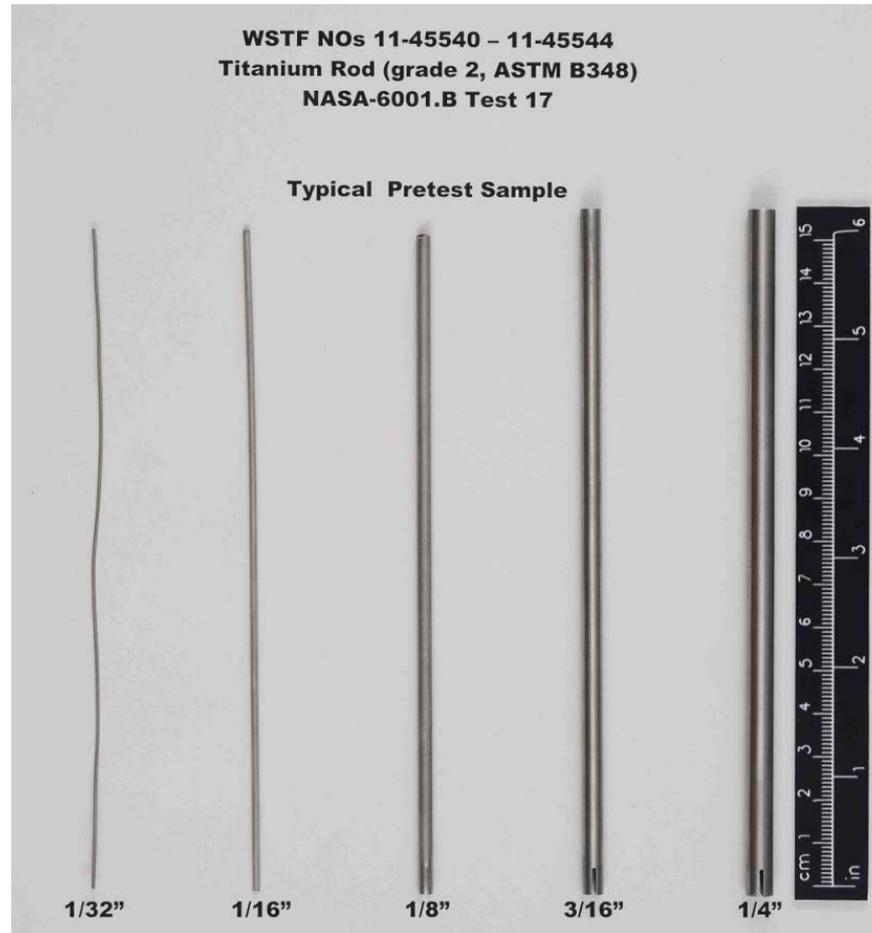


Experimental

- Test Samples
- Ignition Promoters
- Test Apparatus
- Test Procedure
- Test Conditions

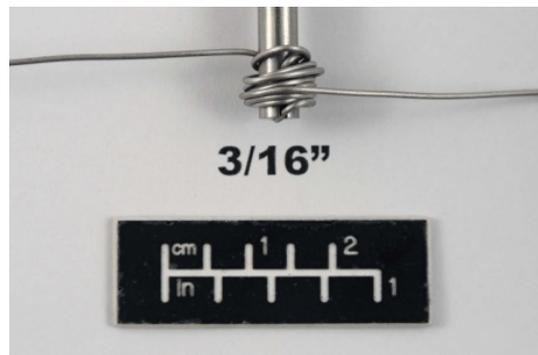
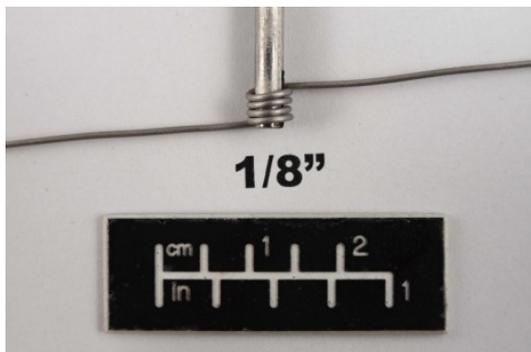
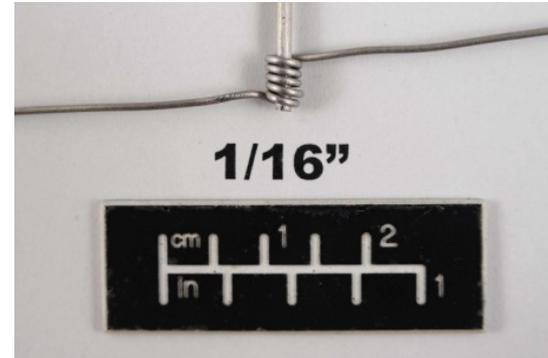


Test Samples



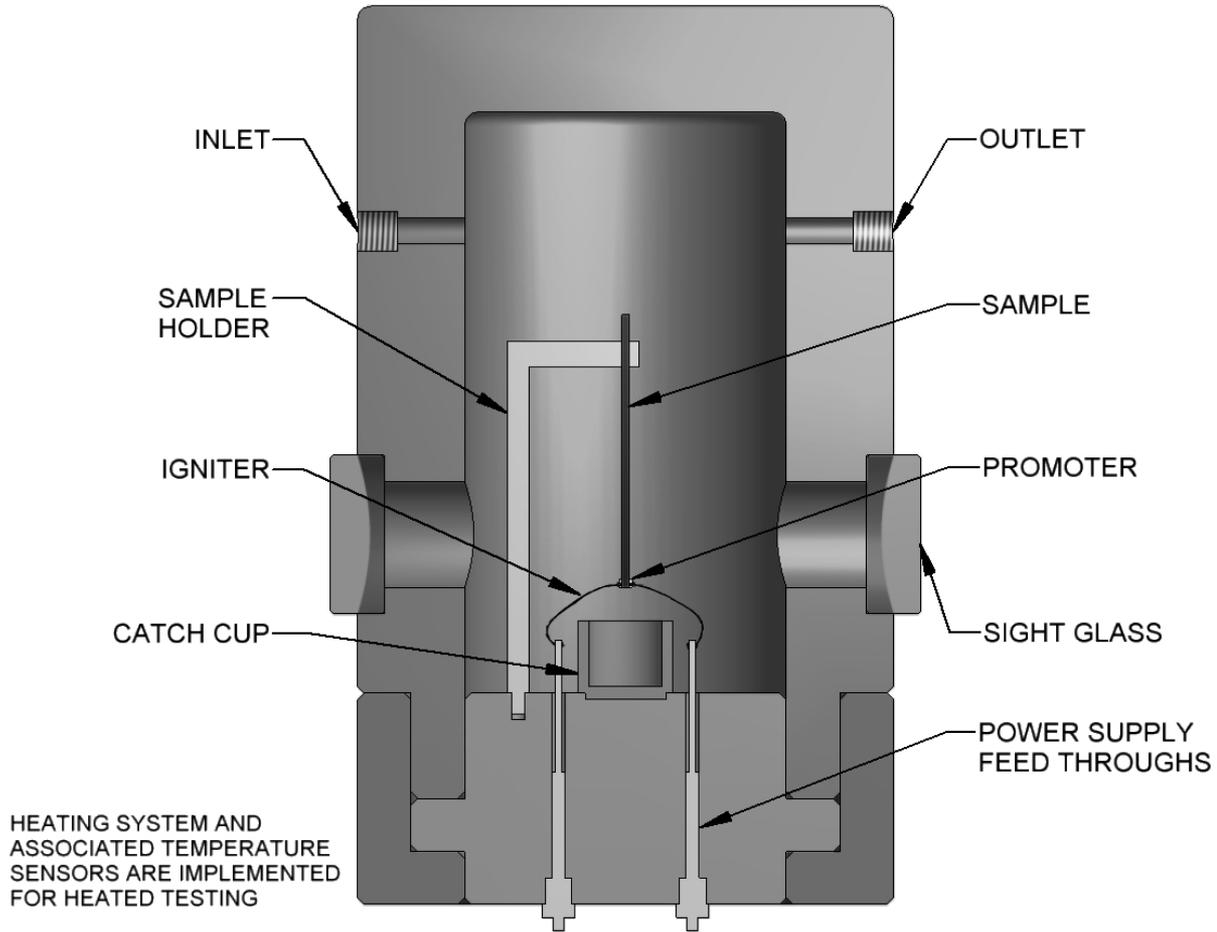


Ignition Promoters



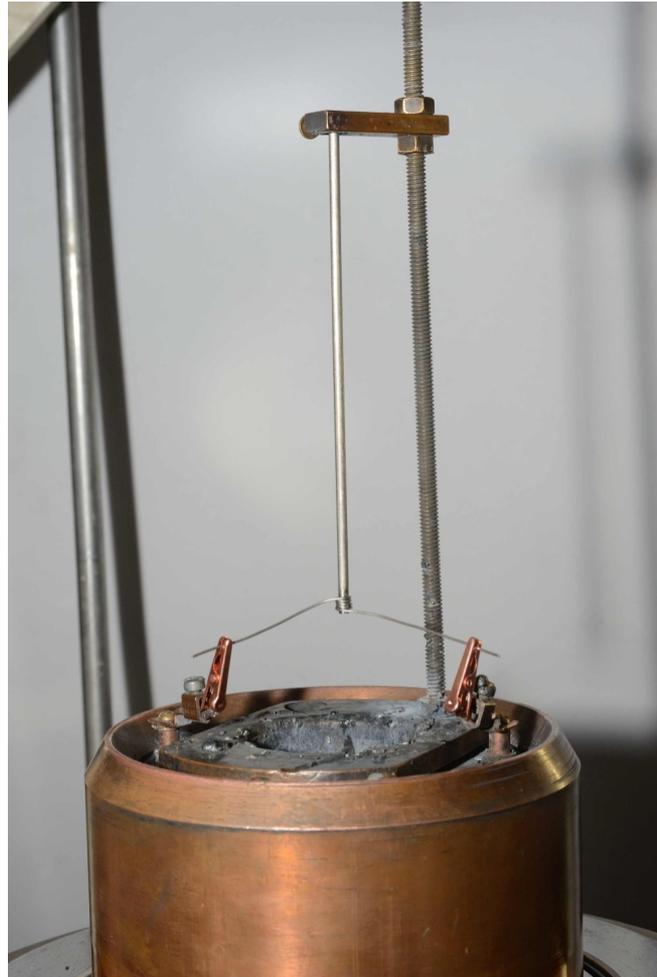


Test Apparatus





Test Apparatus





Test Procedure

- Samples Prepped
- Chamber Purged
- Chamber Pressurized
- Sample Ignited
- Test Observed and Data Recorded



Test Conditions at 70% O₂

- Each Diameter
 - 25 psia (0.2 MPa)
 - 200 psia (1.4 MPa)
- 1/8-in (3.2 mm) Diameter
 - 25 psia (0.2 MPa)
 - 50 psia (0.4 MPa)
 - 100 psia (0.7 MPa)
 - 200 psia (1.4 MPa)



Test Conditions at 99.5% O₂

- 1/8-in (3.2 mm) diameter
 - 14.4 psia (0.09 MPa)
 - 25 psia (0.2 MPa)
 - 50 psia (0.4 MPa)
 - 100 psia (0.7 MPa)
 - 200 psia (1.4 MPa)



Results

- Uncertainty Analysis
- Tests in 70 % O₂ at 25 psia (0.2 MPa)
- Tests in 70 % O₂ at 200 psia (1.4 MPa)
- Tests in 99.5+% Oxygen



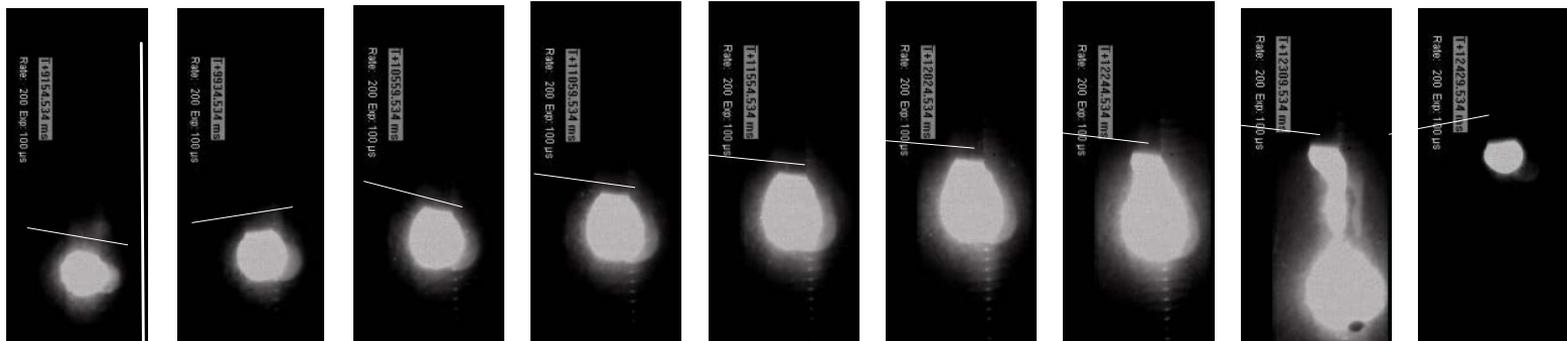
Uncertainty Analysis

- **Video...**



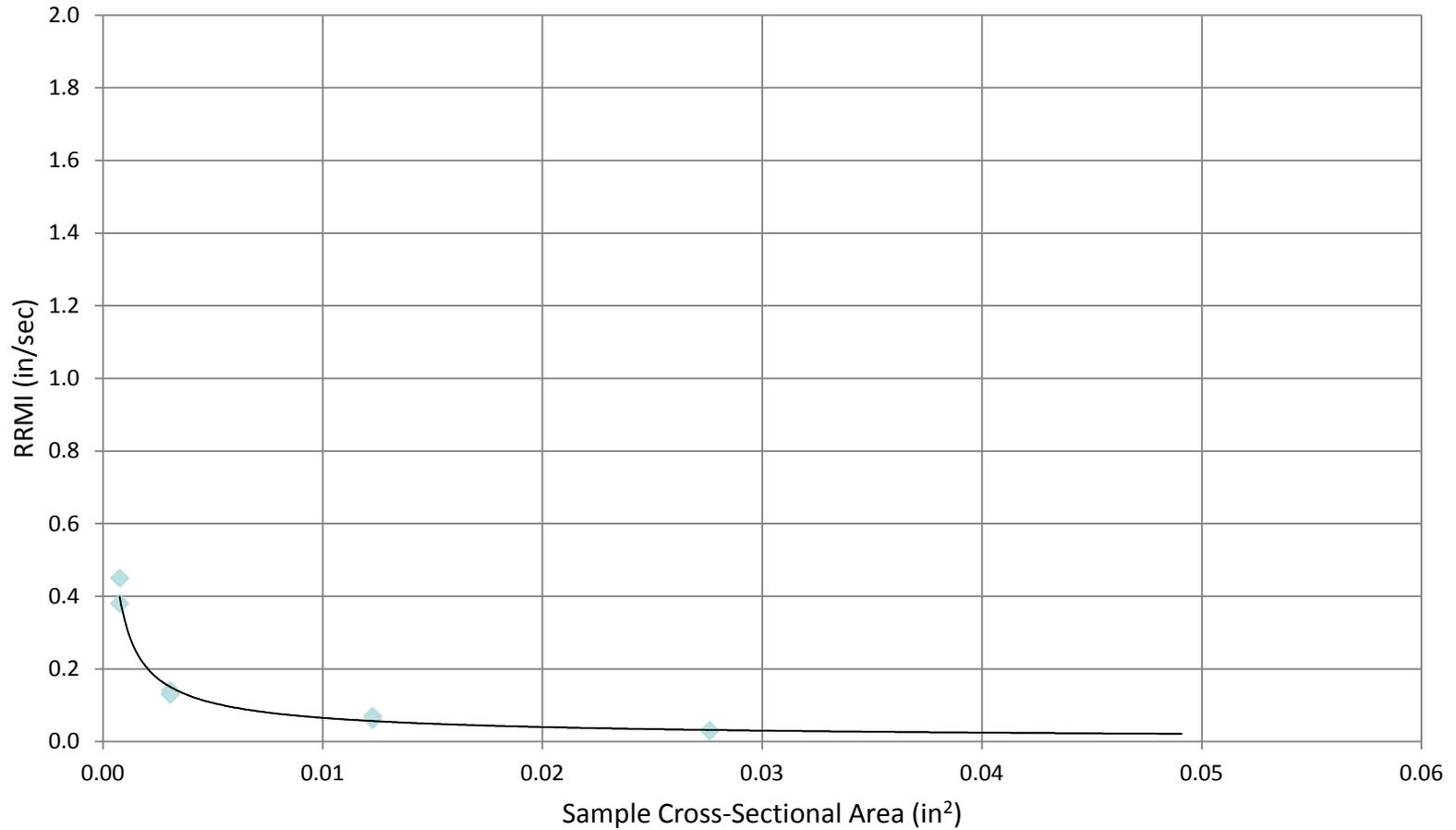
Uncertainty Analysis

- Sources of Error
 - Clock jitter
 - Pixel bleed
 - Melting interface position
 - Tilt of measuring interface
- Calculated Error
 - 2.7%-10% dependant on sample diameter



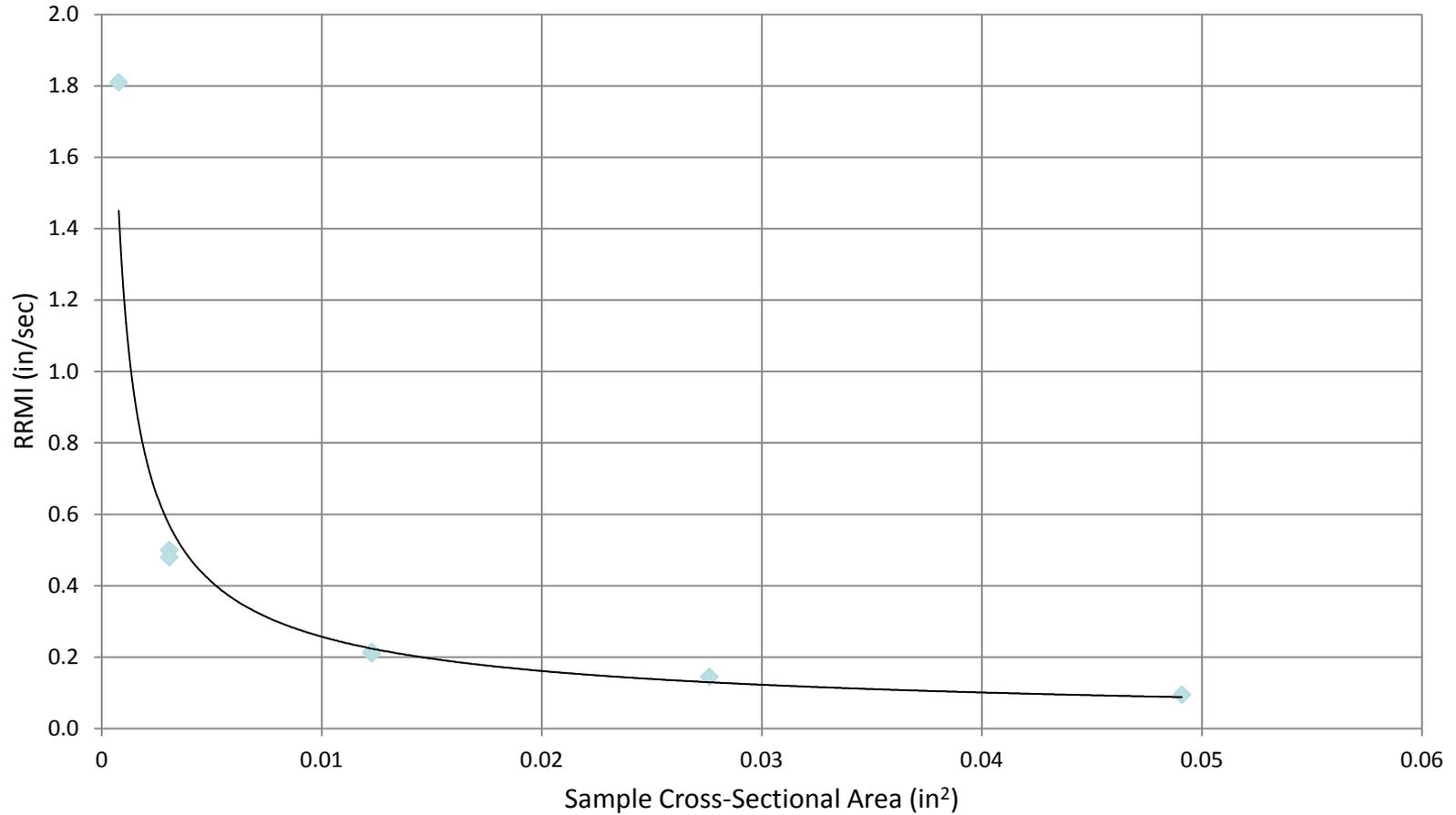


Tests in 70 % O₂ at 25 psia (0.2 MPa)



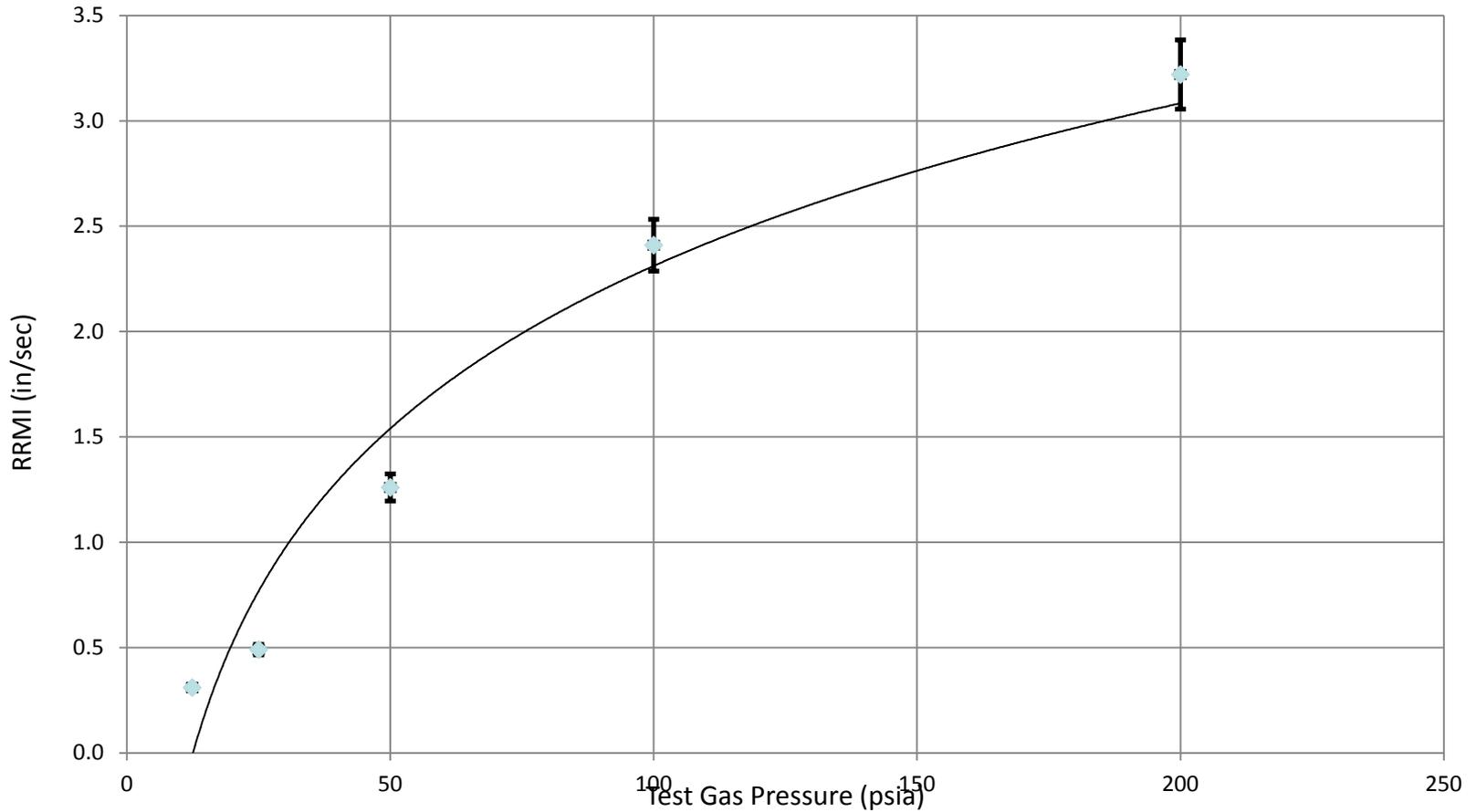


Tests in 70 % O₂ 200 psia (1.4 MPa)





RRMI of 1/8 in (3.2 mm) Rods in 99.5+% Oxygen



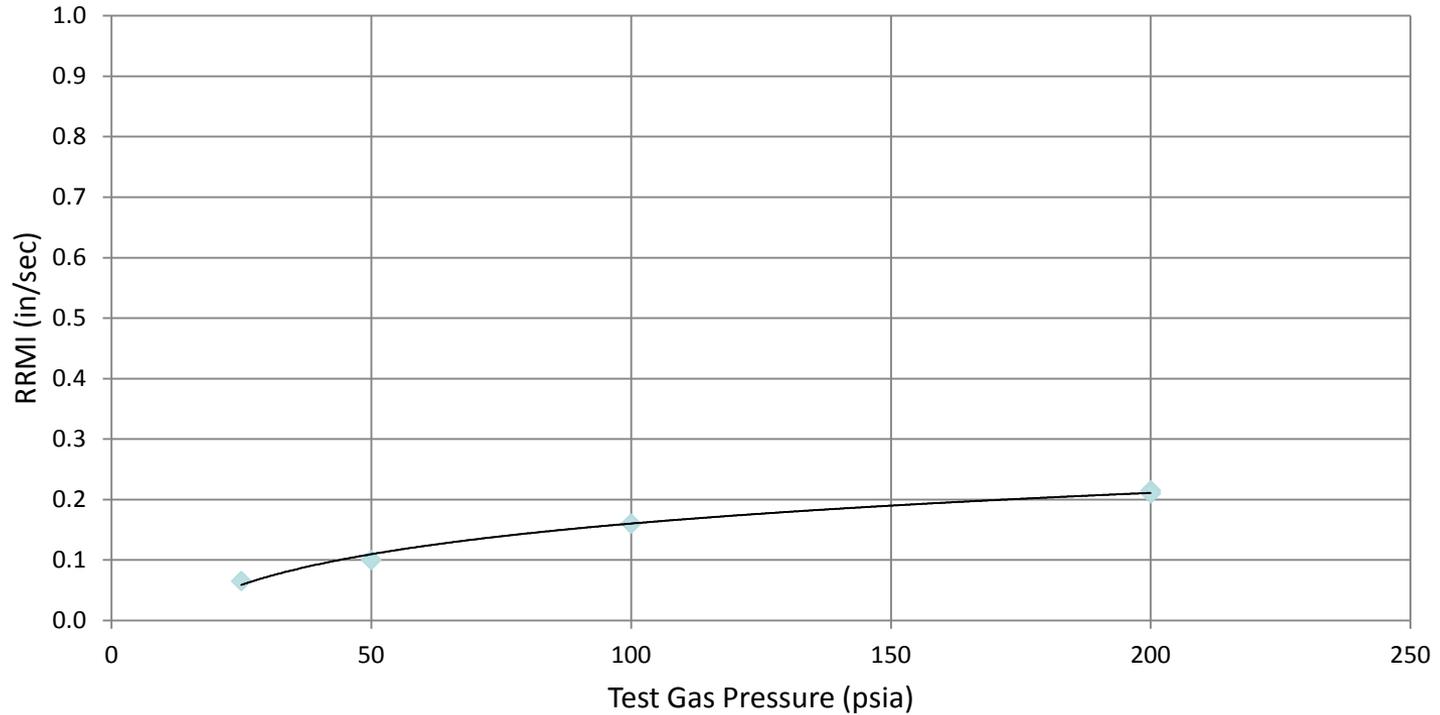


Discussion

- In almost all conditions samples fully consumed
- Effect of Test Gas Pressure on RRMI (70% O₂)
- Effect of Test Gas Pressure and Cross-sectional Area on RRMI (70% O₂)
- Effect of Oxygen Concentration on RRMI

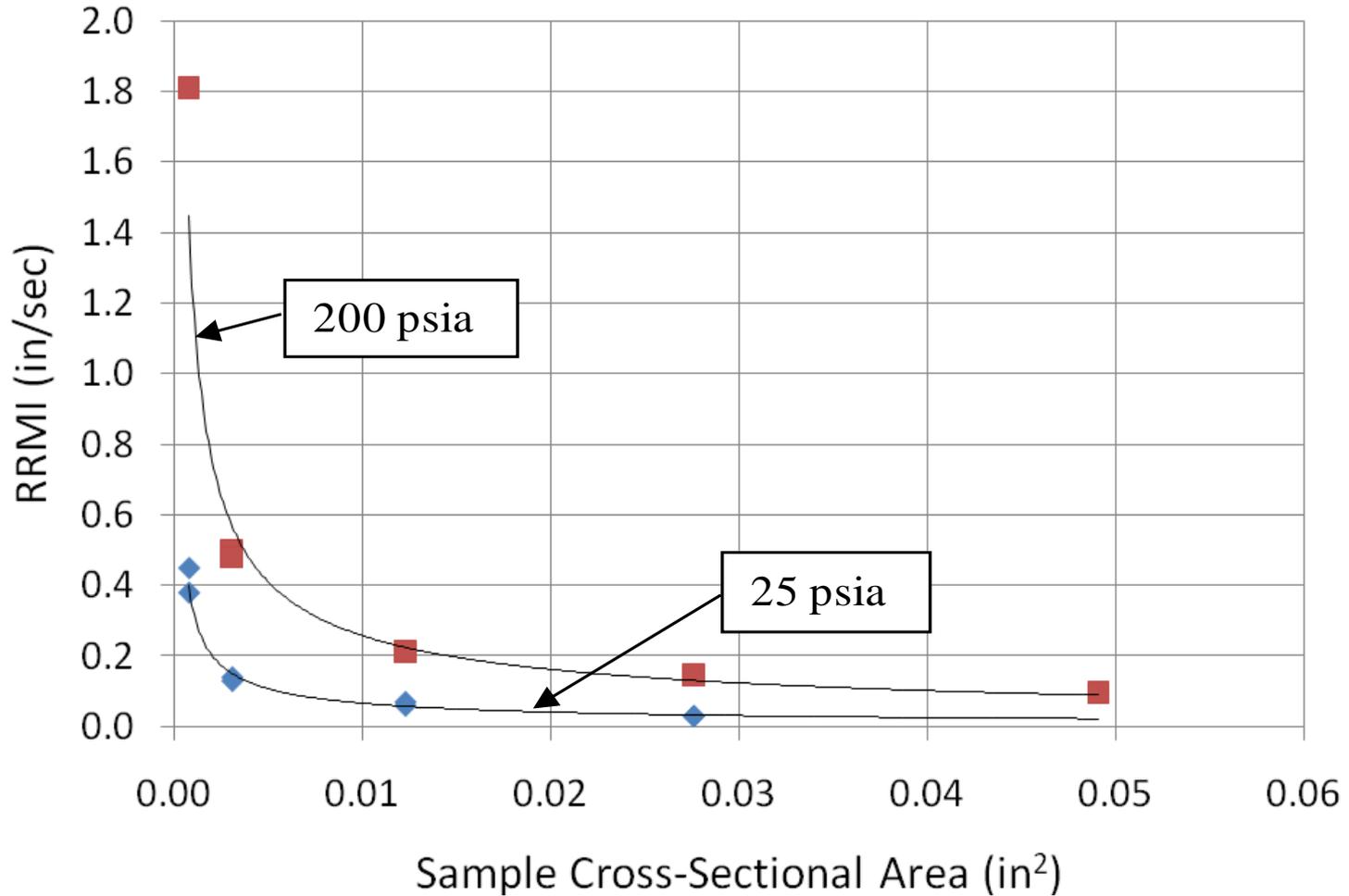


RRMI of 1/8-in (3.2 mm) Rods in 70 % O₂



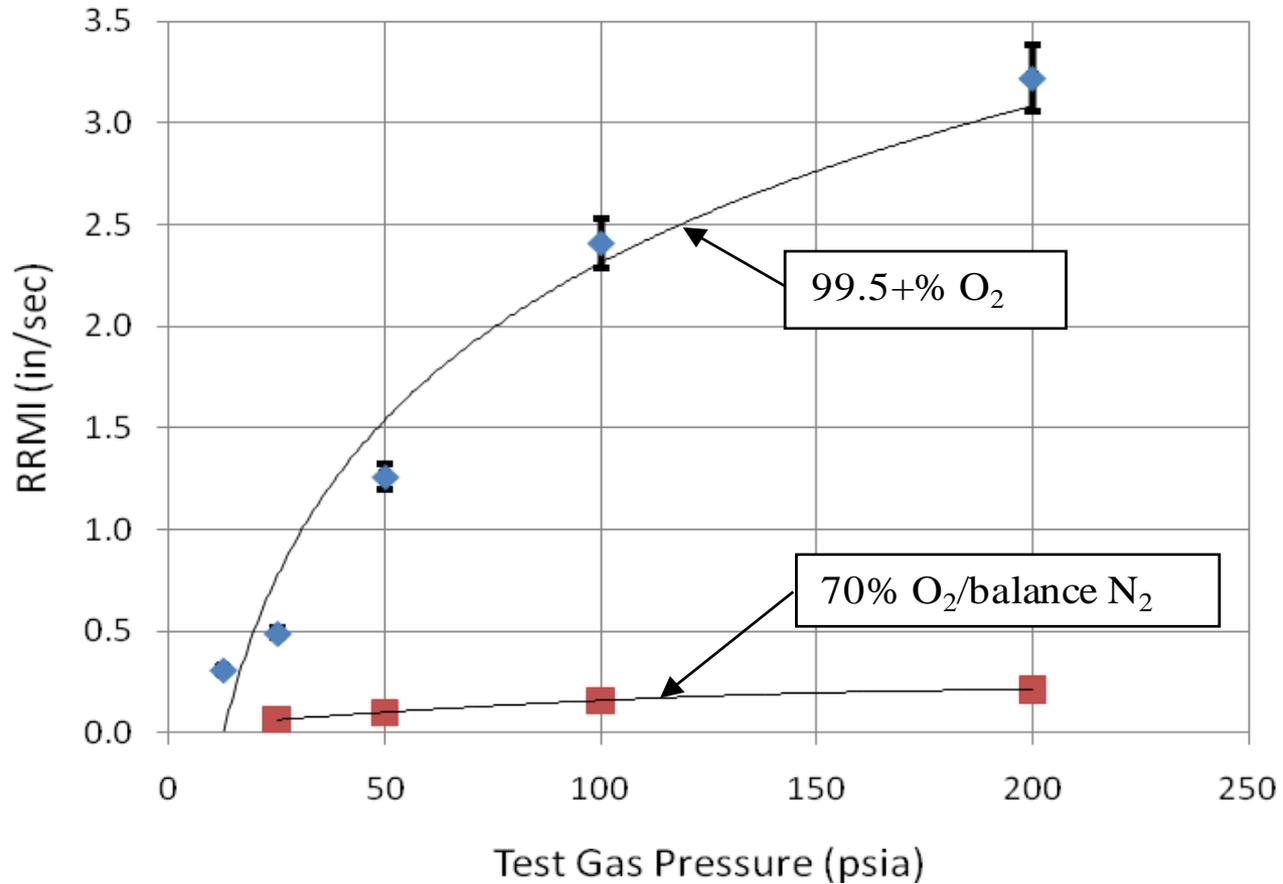


Effect of RRMI in 70% Oxygen





Effect of Oxygen Concentration on RRMI of 1/8 in (3.2 mm) Rods





Conclusion

- CP Ti (Grade 2) flammable in 70% O₂ as low as 25 psia (0.2 MPa) up to 3/16 in (5.8 mm) dia
 - Up to 1/4 in (6.4 mm) dia flammable at 200 psia (1.4 MPa)
 - RRMI increased as cross-sectional area decreased
 - RRMI increased as pressure increased
 - 70% O₂ increase by 3.3-4.8 times (dia dependant)
 - For 1/8 in (3.2 mm) rods at 99.5 + % O₂ increased over an order of magnitude from 12.4-200 psia (0.09-1.4 MPa)
 - O₂ concentration had much more marked affect on RRMI than O₂ pressure.
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