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Life Prediction Methodology for Ceramic Components of Advanced Vehicular Heat Engines

Volume II - Final Report Appendices I and II

P. K. Khandelwal
N. J. Provenzano
W. E. Schneider

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LIFE PREDICTION METHODOLOGY FOR CERAMIC COMPONENTS OF
ADVANCED VEHICULAR HEAT ENGINES

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TABLE OF CONTENTS

<u>Appendix</u>	<u>Title</u>
I.	Fast Fracture Testing of MOR Type-B (3 x 4 x 50 mm) Specimens in Air at Allison from 25°C to 1400°C
II.	Fast Fracture Tensile Testing of Button-Head Specimens in Air at Southern Research Institute from 25°C to 1400°C

Research sponsored by the U.S. Department of Energy, Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Transportation Technologies, as part of the Propulsion Systems Materials Program, under contract DE-AC05-96OR22464 with Lockheed Martin Energy Research Corporation.

APPENDIX I

**FAST FRACTURE TESTING OF MOR TYPE-B (3 x 4 x 50 mm) SPECIMENS IN AIR
AT ALLISON FROM 25°C TO 1400°C**

MATERIAL: GTE PY-6 SILICON NITRIDE

SPECIMEN: MIL STD. 1942 SPECIMEN 'B'

PROCESS: INJECTION MOLDED AND HIP'ED

DIMEN.: 3 x 4 x 50 mm

TEMP.: ROOMTEMPERATURE

CROSS-HEAD SPEED: 0.5 mm/min (0.020 in./min)

SPECIMEN NUMBER	LOT NUMBER	WIDTH inches	THICKNESS inches	FAILURE STRENGTH KSI	FAILURE STRENGTH MPa	FAILURE TYPE	FAILURE		ORIGIN
							X MM	Y MM	
34.1396	Q21-19	0.1586	0.1184	89.25	615.35	SFC (I)	13.8	0.2	
34.1397	Q21-19	0.1585	0.1186	101.19	697.68	SFC (I)	31.1	3.8	
34.1398	Q21-19	0.1586	0.1184	101.46	699.60	SFC (I)	33.9	3.8	
34.1399	Q21-19	0.1587	0.1182	120.39	830.08	SFC (I)	15.7	3.8	
34.1400	Q21-19	0.1588	0.1184	117.78	812.12	SFC (I)	2.5	3.8	
34.1401	Q21-19	0.1587	0.1181	113.66	783.65	SFC (I)	15.9	3.8	
34.1402	Q21-19	0.1588	0.1184	132.64	914.55	SFC (I)	17.1	3.8	
34.1403	Q21-19	0.1587	0.1184	124.76	860.22	SFC (I)	28.0	0.2	
34.1404	Q21-19	0.1586	0.1187	117.34	809.04	SFC (I)	3.5	3.8	
34.1405	Q21-19	0.1586	0.1185	126.22	870.28	SF	2.6	2.1	
34.1406	Q21-19	0.1586	0.1186	126.75	873.93	SFC (I)	26.2	0.2	
34.1407	Q21-19	0.1586	0.1186	112.24	773.90	SFC (I)	25.3	3.8	
34.1408	Q21-19	0.1585	0.1186	98.01	675.76	S	15.7	1.3	
34.1409	Q21-19	0.1585	0.1185	105.60	728.13	SFC (I)	12.5	0.2	
34.1410	Q21-19	0.1587	0.1183	61.16	421.67	SFC (I)	26.3	3.8	
34.1411	Q21-19	0.1587	0.1184	98.22	677.19	SFC (I)	17.0	3.8	
34.1412	Q21-19	0.1588	0.1184	109.83	757.25	SFC (I)	30.2	3.8	
34.1413	Q21-19	0.1587	0.1184	111.49	768.71	SFC (I)	15.3	3.8	
34.1414	Q21-19	0.1587	0.1183	136.14	938.67	SFC (I)	12.9	0.2	
34.1415	Q21-19	0.1587	0.1183	133.48	920.34	SFC (I)	39.4	3.8	
34.1946	Q21-17	0.1568	0.1167	157.60	1086.87	SF	31.0	2.0	
34.1947	Q21-17	0.1585	0.1182	153.60	1059.13	SFC (I)	17.5	3.8	
34.1948	Q21-17	0.1584	0.1183	115.60	797.18	SFC (I)	35.7	4.0	
34.1949	Q21-17	0.1586	0.1183	130.40	898.91	SFC (I)	15.5	4.0	
34.1950	Q21-17	0.1585	0.1182	144.00	992.93	S	12.5	0.8	
34.1951	Q21-17	0.1585	0.1181	136.20	939.36	SF	29.0	0.5	
34.1952	Q21-17	0.1585	0.1182	111.50	768.60	SFC (I)	20.5	3.8	
34.1953	Q21-17	0.1584	0.1184	161.70	1114.90	SFC (I)	27.0	0.2	
34.1954	Q21-17	0.1584	0.1184	110.60	762.83	SFC (I)	24.9	3.8	
34.1955	Q21-17	0.1857	0.1184	123.20	849.24	SFC (I)	25.4	0.2	
34.1956	Q21-17	0.1588	0.1184	122.00	841.39	SFC (I)	30.4	3.8	
34.1957	Q21-17	0.1587	0.1185	120.30	829.53	SFC (I)	32.7	3.8	
34.1958	Q21-17	0.1589	0.1185	143.40	989.08	SF	28.5	0.5	
34.1959	Q21-17	0.1588	0.1183	141.90	978.39	SF	16.5	1.0	
34.1960	Q21-17	0.1588	0.1183	149.30	1029.69	SFC (I)	31.9	3.8	
34.1961	Q21-17	0.1589	0.1184	122.50	844.51	SFC (I)	13.0	3.8	
34.1962	Q21-17	0.1587	0.1183	146.20	1008.34	SF	26.7	0.8	
34.1963	Q21-17	0.1587	0.1183	126.60	872.67	SFC (I)	17.4	0.2	
34.1964	Q21-17	0.1587	0.1182	132.10	910.88	SF	15.9	3.7	
34.1965	Q21-17	0.1587	0.1183	83.50	575.67	SF	34.1	0.2	
34.1596	Q21-90-34	0.1577	0.1186	139.50	961.88	SFC (I)			
34.1598	Q21-90-34	0.1573	0.1184	141.94	978.67	SFC (I)			
34.1599	Q21-90-34	0.1580	0.1187	106.11	731.63	SF			
34.1600	Q21-90-34	0.1579	0.1186	79.77	550.00	SFC (I)			
34.1601	Q21-90-34	0.1577	0.1185	118.94	820.08	SFC (I)			
34.1602	Q21-90-34	0.1576	0.1183	72.83	502.15	SFC (I)			
34.1603	Q21-90-34	0.1576	0.1184	70.57	486.56	SFC (I)			
34.1604	Q21-90-34	0.1574	0.1186	108.83	750.37	SFC (I)			

34.1605	Q21-90-34	0.1576	0.1184	87.67	604.51	SF		
34.1711	Q21-90-42	0.1574	0.1184	66.37	457.65	SFC (I)	22.0	0.2
34.1712	Q21-90-42	0.1574	0.1183	105.63	728.30	SF	39.2	3.7
34.1713	Q21-90-42	0.1573	0.1183	92.28	636.28	SFC (I)	30.6	0.2
34.1714	Q21-90-42	0.1578	0.1189	101.12	697.24	SFC (I)	18.3	0.2
34.1715	Q21-90-42	0.1576	0.1186	111.89	771.46	SFC (I)	11.0	0.2
34.1716	Q21-90-42	0.1577	0.1185	126.41	871.57	SFC (I)	29.0	0.2
34.1717	Q21-90-42	0.1577	0.1186	94.78	653.49	SFC (I)	15.3	3.8
34.1718	Q21-90-42	0.1575	0.1186	89.57	617.56	SFC (I)	20.5	0.2
34.1719	Q21-90-42	0.1576	0.1186	123.61	852.28	SFC (I)	35.5	0.2
34.1720	Q21-90-42	0.1576	0.1186	137.99	951.47	SFC (I)	33.0	3.8
34.1721	Q21-90-42	0.1576	0.1186	91.64	631.86	SFC (I)	27.0	3.8
34.1722	Q21-90-42	0.1574	0.1185	83.36	574.78	SFC (I)	25.6	3.8
34.1723	Q21-90-42	0.1574	0.1184	80.29	553.61	SFC (I)	34.4	3.8
34.1724	Q21-90-42	0.1576	0.1185	95.00	655.01	SFC (I)	34.8	3.8
34.1991	Q21-90-64	0.1578	0.1180	120.95	833.94	SFC (I)	31.0	3.8
34.1992	Q21-90-64	0.1578	0.1181	124.50	858.42	SFC (I)	18.8	4.0
34.1993	Q21-90-64	0.1576	0.1182	125.52	856.46	SFC (I)	16.3	3.8
34.1994	Q21-90-64	0.1581	0.1181	102.84	709.07	SFC (I)	16.6	3.8
34.1995	Q21-90-64	0.1578	0.1181	133.09	917.63	SFC (I)	31.8	3.8
34.1996	Q21-90-64	0.1576	0.1182	130.35	898.74	SFC (I)	26.1	3.8
34.1997	Q21-90-64	0.1578	0.1181	135.23	932.43	SF	23.0	2.5
34.1998	Q21-90-64	0.1577	0.1181	127.80	881.18	SFC (I)	25.5	3.8
34.1999	Q21-90-64	0.1576	0.1179	137.48	947.93	SF	36.2	2.0
34.2000	Q21-90-64	0.1580	0.1180	124.55	858.79	SFC (I)	23.5	0.2
34.2001	Q21-90-64	0.1589	0.1181	141.22	973.74	SFC (I)	20.1	3.8
34.2002	Q21-90-64	0.1570	0.1181	149.95	1033.87	SFC (I)	29.6	3.8
34.2003	Q21-90-64	0.1586	0.1180	137.45	947.73	SF	28.1	3.5
34.2004	Q21-90-64	0.1587	0.1181	137.67	949.21	SFC (I)	28.2	0.2
34.2005	Q21-90-64	0.1586	0.1182	150.31	1036.41	SFC (I)	19.1	0.2
34.2006	Q21-90-64	0.1586	0.1181	129.21	890.91	SFC (I)	23.1	0.2
34.2007	Q21-90-64	0.1587	0.1179	128.50	885.99	SFC (I)	36.5	0.2
AVERAGE				117.91	812.86			
STD. DEV.				22.30	153.78			
NUMBER OF SPECIMENS TESTED:				80				
NUMBER OF SPECIMENS WITH EXTERNAL FAILURES:				80				
SF = SURFACE FLAW:				14				
SFC = SURFACE FLAW CORNER:				64	I= INTERNAL	E= EXTERNAL		
SFI = SURFACE FLAW INCLUSION:				2				
NUMBER OF SPECIMENS WITH INTERNAL FAILURES:				0				
II = INTERNAL INCLUSION				0				
IP = INTERNAL PORE				0				

MATERIAL: GTE PY-6 SILICON NITRIDE
 SPECIMEN: MIL STD. 1942 SPECIMEN 'B'
 PROCESS: INJECTION MOLDED AND HIP'ED
 DIMEN.: 3 x 4 x 50 mm
 TEMP.: 1000°C
 CROSS-HEAD SPEED: 0.5 mm/min (0.020 in./min)

SPECIMEN NUMBER	LOT NUMBER	WIDTH inches	THICKNESS inches	FAILURE STRENGTH KSI	FAILURE STRENGTH MPa	TYPE	FAILURE	ORIGIN
							X MM	Y MM
34.1465	Q21-19	0.1588	0.1189	112.06	772.66	SF		
34.1466	Q21-19	0.1585	0.1182	105.61	728.15	SF		
34.1467	Q21-19	0.1583	0.1186	104.50	720.50	SF		
34.1469	Q21-19	0.1583	0.1185	102.55	707.07	II		
34.1526	Q21-19	0.1584	0.1178	96.72	666.88	SFC (I)	31.8	0.2
34.1527	Q21-19	0.1584	0.1179	92.26	636.16	SFC (I)	30.0	0.2
34.1528	Q21-19	0.1585	0.1189	88.55	610.57	SFC (I)	26.5	3.8
34.1529	Q21-19	0.1585	0.1184	121.20	835.65	P	22.0	3.3
34.1530	Q21-19	0.1585	0.1187	111.59	769.44	SFC (I)	31.9	0.2
34.1725	Q21-90-42	0.1580	0.1188	119.17	821.70	SFC (I)	17.0	0.2
34.1726	Q21-90-42	0.1577	0.1188	123.11	848.88	II	12.0	1.2
34.1727	Q21-90-42	0.1578	0.1188	98.11	676.34	SFC (I)	25.7	0.2
34.1728	Q21-90-42	0.1578	0.1187	90.84	628.34	SF	30.4	0.3
34.1729	Q21-90-42	0.1578	0.1187	123.78	853.43	SF	33.1	2.1
34.1811	Q21-90-42	0.1573	0.1182	101.57	700.36	SFC (I)	34.2	3.8
34.2021	Q21-90-64	0.1570	0.1181	118.66	818.17	SF	24.2	0.3
34.2022	Q21-90-64	0.1588	0.1180	118.53	817.63	SF	30.6	1.7
34.2023	Q21-90-64	0.1587	0.1181	111.52	768.94	SFC (I)	19.0	3.8
34.2024	Q21-90-64	0.1588	0.1182	108.92	745.13	SFC (I)	27.5	3.8
34.2025	Q21-90-64	0.1588	0.1181	110.92	764.78	II	24.0	2.8
AVERAGE				108.01	744.54			
STD. DEV.				10.69	73.57			
NUMBER OF SPECIMENS TESTED:					20			
NUMBER OF SPECIMENS WITH EXTERNAL FAILURES:					16			
SF = SURFACE FLAW:				7	I= INTERNAL	E= EXTERNAL		
SFC = SURFACE FLAW CORNER:				9				
SFI = SURFACE FLAW INCLUSION:				0				
NUMBER OF SPECIMENS WITH INTERNAL FAILURES:					4			
II = INTERNAL INCLUSION				3				
IP = INTERNAL PORE				1				

MATERIAL: GTE PY-6 SILICON NITRIDE SPECIMEN: MIL STD. 1942 SPECIMEN 'B' PROCESS: INJECTION MOLDED AND HIP'ED DIMEN.: 3 x 4 x 50 mm TEMP.: 1100°C CROSS-HEAD SPEED: 0.5 mm/min (0.020 in./min)								
SPECIMEN NUMBER	LOT NUMBER	WIDTH inches	THICKNESS inches	FAILURE STRENGTH KSI	FAILURE STRENGTH MPa	FAILURE TYPE	FAILURE	ORIGIN
							X MM	Y MM
34.1436	Q21-19	0.1584	0.1189	79.12	545.50	SFC (I)		
34.1437	Q21-19	0.1585	0.1188	85.58	576.29	SF		
34.1438	Q21-19	0.1582	0.1188	90.29	622.52	II		
34.1439	Q21-19	0.1582	0.1187	78.95	944.38	SF		
34.1475	Q21-19	0.1586	0.1186	79.42	547.54	SF		
34.1531	Q21-19	0.1584	0.1179	77.78	536.30	SF	17.3	2.5
34.1532	Q21-19	0.1585	0.1183	79.34	547.03	SF	21.6	1.3
34.1533	Q21-19	0.1586	0.1188	74.93	516.62	SF	27.7	0.6
34.1534	Q21-19	0.1586	0.1190	85.19	587.41	SF	17.8	1.2
34.1535	Q21-19	0.1584	0.1176	80.87	557.63	SFC (I)	33.0	0.2
34.1630	Q21-90-34	0.1578	0.1186	89.93	620.06	SF	19.1	0.2
34.1631	Q21-90-34	0.1578	0.1185	89.01	613.75	SFC (I)	16.0	3.2
34.1632	Q21-90-34	0.1578	0.1186	90.99	627.39	SF	30.7	1.9
34.1633	Q21-90-34	0.1577	0.1185	69.87	481.75	SF	32.9	3.7
34.1634	Q21-90-34	0.1578	0.1187	83.40	575.06	SFC (I)	22.2	3.8
34.2008	Q21-90-64	0.1586	0.1180	89.85	619.53	SFC (I)	19.1	0.2
34.2009	Q21-90-64	0.1587	0.1179	93.16	642.34	SFC (I)	15.3	3.8
34.2010	Q21-90-64	0.1586	0.1181	87.56	603.76	SF	34.2	1.8
34.2011	Q21-90-64	0.1587	0.1180	93.00	641.25	SF	33.3	2.9
34.2012	Q21-90-64	0.1588	0.1179	96.85	667.76	SF	16.1	2.3
AVERAGE				84.75	603.69			
STD. DEV.				6.86	90.92			
NUMBER OF SPECIMENS TESTED:				20				
NUMBER OF SPECIMENS WITH EXTERNAL FAILURES:				19				
SF = SURFACE FLAW:				13				
SFC = SURFACE FLAW CORNER:				6	I= INTERNAL	E= EXTERNAL		
SFI = SURFACE FLAW INCLUSION:				0				
NUMBER OF SPECIMENS WITH INTERNAL FAILURES:				1				
II = INTERNAL INCLUSION				1				
IP = INTERNAL PORE				0				

MATERIAL: GTE PY-6 SILICON NITRIDE
 SPECIMEN: MIL STD. 1942 SPECIMEN 'B'
 PROCESS: INJECTION MOLDED AND HIP'ED
 DIMEN.: 3 x 4 x 50 mm
 TEMP.: 1200°C
 CROSS-HEAD SPEED: 0.5 mm/min (0.020 in./min)

SPECIMEN NUMBER	LOT NUMBER	WIDTH Inches	THICKNESS inches	FAILURE STRENGTH KSI	FAILURE STRENGTH MPa	FAILURE TYPE	FAILURE ORIGIN	
							X MM	Y MM
34.1426	Q21-19	0.1585	0.1185	90.74	625.68	SFI	30.1	1.4
34.1427	Q21-19	0.1587	0.1184	86.00	593.00	SFI	28.3	1.6
34.1428	Q21-19	0.1586	0.1185	100.76	694.76	SF	17.6	3.2
34.1429	Q21-19	0.1586	0.1185	103.94	716.70	SFI	26.4	2.8
34.1430	Q21-19	0.1587	0.1185	83.74	577.38	SF	19.2	3.2
34.1431	Q21-19	0.1586	0.1185	66.82	460.74	II		
34.1432	Q21-19	0.1586	0.1184	95.15	662.97	II		
34.1433	Q21-19	0.1585	0.1188	93.98	648.01	SF		
34.1434	Q21-19	0.1583	0.1177	73.25	505.04	SF		
34.1435	Q21-19	0.1586	0.1181	84.89	585.35	SF		
34.1460	Q21-19	0.1588	0.1183	96.72	666.92	SF		
34.1461	Q21-19	0.1583	0.1186	81.16	559.58	SFC (I)		
34.1462	Q21-19	0.1587	0.1188	90.17	621.74	II		
34.1463	Q21-19	0.1584	0.1192	82.92	571.70	SF		
34.1464	Q21-19	0.1584	0.1189	83.86	587.23	P		
34.1536	Q21-19	0.1538	0.1184	101.12	697.25	SF	33.0	3.2
34.1537	Q21-19	0.1536	0.1191	101.33	698.64	SF	15.0	3.6
34.1538	Q21-19	0.1586	0.1180	88.25	608.47	II	20.5	0.6
34.1539	Q21-19	0.1585	0.1184	87.71	604.74	SF	24.6	3.3
34.1540	Q21-19	0.1585	0.1188	77.09	531.51	SFC (I)	14.0	0.2
34.1510	Q21-19	0.1584	0.1180	102.28	705.24	SF	31.4	2.8
34.1511	Q21-19	0.1584	0.1180	94.25	649.85	P	32.0	2.2
34.1512	Q21-19	0.1584	0.1187	91.50	630.86	SF	23.7	2.9
34.1513	Q21-19	0.1586	0.1191	99.23	684.16	SF	31.7	2.0
34.1514	Q21-19	0.1584	0.1179	86.90	599.17	SFI	23.2	0.9
34.1515	Q21-19	0.1584	0.1181	79.66	549.23	SF	30.5	2.3
34.1521	Q21-19	0.1585	0.1181	95.63	659.39	II	34.2	1.8
34.1522	Q21-19	0.1587	0.1189	86.86	598.91	SFC (I)	19.4	3.8
34.1523	Q21-19	0.1583	0.1179	85.34	588.45	II	20.5	1.3
34.1524	Q21-19	0.1584	0.1178	79.52	548.32	II	34.9	0.7
34.1606	Q21-90-34	0.1576	0.1186	99.63	686.97	II		
34.1608	Q21-90-34	0.1580	0.1188	92.69	639.10	SF		
34.1609	Q21-90-34	0.1578	0.1186	94.19	649.41	SF		
34.1610	Q21-90-34	0.1576	0.1185	96.07	662.37	SFI		
34.1612	Q21-90-34	0.1578	0.1187	96.56	665.78	SFI		
34.1613	Q21-90-34	0.1580	0.1183	107.10	738.46	SF		
34.1614	Q21-90-34	0.1576	0.1187	83.40	575.06	SF		
34.1615	Q21-90-34	0.1578	0.1186	94.66	652.66	II		
34.1647	Q21-90-34	0.1577	0.1188	83.46	575.42	SFC (I)	21.3	0.0
34.1648	Q21-90-34	0.1577	0.1186	98.50	679.19	II	31.5	3.6
34.1649	Q21-90-34	0.1577	0.1185	72.54	500.14	SF	15.1	3.7
34.1650	Q21-90-34	0.1578	0.1187	92.96	640.99	SF	18.1	1.8
34.1651	Q21-90-34	0.1578	0.1187	96.68	666.63	SF	16.5	2.6
34.1652	Q21-90-34	0.1577	0.1186	99.04	682.86	SF	15.1	0.3
34.1653	Q21-90-34	0.1577	0.1185	89.94	599.43	II	15.5	1.4
34.1654	Q21-90-34	0.1577	0.1185	94.94	654.59	SF	25.4	1.4
34.1765	Q21-90-42	0.1575	0.1185	75.83	522.87	SFC (I)	29.3	0.2
34.1766	Q21-90-42	0.1579	0.1189	93.65	645.73	SFC (I)	27.2	3.8

34.1767	Q21-90-42	0.1576	0.1185	98.73	680.77	SFC (I)	30.3	0.2
34.1769	Q21-90-42	0.1575	0.1185	91.32	629.42	SF	23.5	1.7
34.1771	Q21-90-42	0.1575	0.1184	100.57	693.42	SF	28.0	1.6
34.1772	Q21-90-42	0.1576	0.1183	79.25	546.46	SF	36.6	0.2
34.1774	Q21-90-42	0.1575	0.1184	78.64	542.19	SF	33.8	3.5
34.1775	Q21-90-42	0.1575	0.1184	65.80	453.67	SFC (I)	32.8	0.2
34.1776	Q21-90-42	0.1578	0.1187	102.53	706.92	P	22.6	1.8
34.1777	Q21-90-42	0.1577	0.1187	88.24	608.41	SFC (I)	19.1	3.8
34.1901	Q21-90-42	0.1576	0.1185	53.90	371.66	SF	21.6	3.5
34.1902	Q21-90-42	0.1567	0.1185	63.34	436.71	SFC	20.1	0.2
34.1903	Q21-90-42	0.1567	0.1186	72.34	498.79	II	30.0	2.3
34.1904	Q21-90-42	0.1568	0.1185	76.17	525.20	SFC (I)	16.8	3.8
34.1905	Q21-90-42	0.1568	0.1185	84.22	580.68	SF	22.9	0.2
34.1909	Q21-90-42	0.1569	0.1185	93.81	646.84	SF	17.8	2.0
34.1911	Q21-90-42	0.1568	0.1185	92.80	636.86	SF	19.4	2.3
34.1912	Q21-90-42	0.1568	0.1185	98.70	680.54	SF	19.1	1.5
34.1913	Q21-90-42	0.1569	0.1185	97.57	672.72	SFC (I)	34.2	0.2
34.1914	Q21-90-42	0.1569	0.1184	92.36	636.83	SFC (I)	31.6	3.8
34.1915	Q21-90-42	0.1570	0.1185	101.79	701.84	SF	24.9	2.1
34.1916	Q21-90-42	0.1567	0.1186	72.34	498.79	SF	24.2	3.7
34.1917	Q21-90-42	0.1568	0.1186	59.98	413.55	SFC (I)	19.1	3.9
34.1918	Q21-90-42	0.1568	0.1186	53.55	369.24	SF	16.5	0.3
34.1920	Q21-90-42	0.1570	0.1188	57.03	393.25	SF	35.1	3.7
34.1921	Q21-90-42	0.1571	0.1188	87.89	393.25	SF	34.5	0.5
34.1922	Q21-90-42	0.1571	0.1188	83.63	576.65	SFC (I)	20.3	3.8
34.1923	Q21-90-42	0.1571	0.1188	78.84	543.59	SF	35.1	1.6
34.1925	Q21-90-42	0.1571	0.1189	90.94	627.01	SF	30.7	1.3
34.1926	Q21-90-42	0.1570	0.1186	92.53	637.97	SFC (I)	23.4	2.0
34.1927	Q21-90-42	0.1570	0.1187	91.30	629.53	SF	17.2	2.9
34.1928	Q21-90-42	0.1568	0.1186	63.19	435.70	SFC (I)	20.8	3.8
34.2031	Q21-90-64	0.1581	0.1178	95.83	666.72	SF	35.3	3.4
34.2032	Q21-90-64	0.1586	0.1178	94.99	654.94	SFC (I)	29.5	3.8
34.2033	Q21-90-64	0.1587	0.1178	103.51	713.69	SF	32.6	0.4
34.2034	Q21-90-64	0.1587	0.1179	97.98	675.57	SF	34.3	3.3
34.2035	Q21-90-64	0.1585	0.1179	97.57	972.92	SF	17.2	2.8
34.2036	Q21-90-64	0.1586	0.1179	69.65	480.21	SFC (I)	31.1	0.2
34.2037	Q21-90-64	0.1585	0.1181	89.76	618.87	SFI	28.0	2.5
34.2038	Q21-90-64	0.1586	0.1180	91.46	630.59	SF	22.1	3.1
34.2039	Q21-90-64	0.1570	0.1181	85.22	587.60	SFC (I)	16.1	0.2
34.2040	Q21-90-64	0.1588	0.1181	95.99	661.82	SFC (I)	36.0	1.5
AVERAGE				87.70	605.68			
STD. DEV.				12.02	94.19			
NUMBER OF SPECIMENS TESTED:				88				
NUMBER OF SPECIMENS WITH EXTERNAL FAILURES:				73				
SF = SURFACE FLAW:				45				
SFC = SURFACE FLAW CORNER:				21	I = INTERNAL	E = EXTERNAL		
SFI = SURFACE FLAW INCLUSION:				7				
NUMBER OF SPECIMENS WITH INTERNAL FAILURES:				15				
II = INTERNAL INCLUSION				12				
IP = INTERNAL PORE				3				

MATERIAL: GTE PY-6 SILICON NITRIDE
 SPECIMEN: MIL STD. 1942 SPECIMEN 'B'
 PROCESS: INJECTION MOLDED AND HIP'ED
 DIMEN.: 3 x 4 x 50 mm
 TEMP.: 1300°C

CROSS-HEAD SPEED: 0.5 mm/min (0.020 in./min)

SPECIMEN NUMBER	LOT NUMBER	WIDTH inches	THICKNESS inches	FAILURE STRENGTH KSI	FAILURE STRENGTH MPa	FAILURE TYPE	FAILURE	ORIGIN
							X MM	Y MM
34.1421	Q21-19	0.1587	0.1186	83.07	572.76	SF	27.8	3.4
34.1422	Q21-19	0.1587	0.1186	86.77	598.30	SF	16.1	2.8
34.1423	Q21-19	0.1587	0.1186	84.66	583.71	SF	22.0	3.5
34.1424	Q21-19	0.1586	0.1187	82.98	572.16	II	28.4	1.6
34.1425	Q21-19	0.1586	0.1182	87.95	606.41	SF	33.5	1.3
34.1541	Q21-19	0.1586	0.1187	90.38	623.18	SFC (I)	30.1	1.4
34.1542	Q21-19	0.1584	0.1178	89.20	615.01	SF	32.1	2.0
34.1543	Q21-19	0.1584	0.1181	71.10	490.25	SF	32.0	1.0
34.1544	Q21-19	0.1585	0.1187	81.45	561.58	SF	31.5	3.1
34.1545	Q21-19	0.1585	0.1187	87.26	601.69	SF	33.6	1.0
34.1645	Q21-90-34	0.1580	0.1188	66.21	456.50	SF	24.2	1.6
34.1646	Q21-90-34	0.1577	0.1186	83.60	576.39	SF	26.1	2.0
34.1635	Q21-90-34	0.1576	0.1184	76.45	527.11	SF	27.3	3.5
34.1636	Q21-90-34	0.1576	0.1184	86.60	597.14	II	35.7	1.8
34.1637	Q21-90-34	0.1575	0.1184	92.01	634.40	II	25.2	2.3
34.1638	Q21-90-34	0.1577	0.1186	88.92	613.11	II	36.2	1.3
34.1639	Q21-90-34	0.1579	0.1187	78.04	538.09	SF	25.6	3.6
34.1640	Q21-90-34	0.1581	0.1187	98.09	676.33	SFI	21.3	3.6
34.1641	Q21-90-34	0.1580	0.1190	80.77	556.88	II	24.1	3.3
34.1642	Q21-90-34	0.1574	0.1183	73.46	506.49	SFC (I)	33.2	0.2
34.1643	Q21-90-34	0.1576	0.1184	84.47	582.40	P	17.2	0.4
34.1644	Q21-90-34	0.1577	0.1184	56.10	386.79	II	19.5	1.3
34.1760	Q21-90-42	0.1575	0.1184	88.26	608.58	SF	19.3	1.9
34.1761	Q21-90-42	0.1576	0.1183	89.96	620.30	SF	28.2	1.2
34.1762	Q21-90-42	0.1576	0.1184	78.59	541.85	SF	33.9	3.7
34.1763	Q21-90-42	0.1576	0.1185	83.53	603.49	SF	35.1	3.4
34.1764	Q21-90-42	0.1575	0.1185	85.98	592.83	SFC (I)	24.4	3.8
34.2026	Q21-90-64	0.1586	0.1181	77.42	533.81	SFC (I)	33.0	0.2
34.2027	Q21-90-64	0.1588	0.1181	75.72	522.11	SF	31.4	0.6
34.2028	Q21-90-64	0.1586	0.1180	79.16	545.78	SF	32.8	1.7
34.2029	Q21-90-64	0.1570	0.1181	76.59	528.09	SF	25.2	1.2
34.2030	Q21-90-64	0.1586	0.1182	84.11	579.95	SF	16.8	2.5
AVERAGE				82.15	567.30			
STD. DEV.				8.00	55.52			
NUMBER OF SPECIMENS TESTED:						32		
NUMBER OF SPECIMENS WITH EXTERNAL FAILURES:						25		
SF = SURFACE FLAW:				20	I= INTERNAL	E= EXTERNAL		
SFC = SURFACE FLAW CORNER:				3				
SFI = SURFACE FLAW INCLUSION:				2				
NUMBER OF SPECIMENS WITH INTERNAL FAILURES:						7		
II = INTERNAL INCLUSION				6				
IP = INTERNAL PORE				1				

MATERIAL: GTE PY-6 SILICON NITRIDE
 SPECIMEN: MIL STD. 1942 SPECIMEN 'B'
 PROCESS: INJECTION MOLDED AND HIP'ED
 DIMEN.: 3 x 4 x 50 mm
 TEMP.: 1400°C
 CROSS-HEAD SPEED: 0.5 mm/min (0.020in./min)

SPECIMEN NUMBER	LOT NUMBER	WIDTH inches	THICKNESS inches	FAILURE STRENGTH KSI	FAILURE STRENGTH MPa	FAILURE TYPE	FAILURE		ORIGIN
							X MM	Y MM	
34.1416	Q21-19	0.1586	0.1183	70.24	484.31	SF	16.6	3.4	
34.1417	Q21-19	0.1586	0.1186	68.83	474.56	SFC (I)	24.0	4.0	
34.1418	Q21-19	0.1587	0.1187	80.82	557.23	SF	34.2	1.0	
34.1419	Q21-19	0.1582	0.1183	75.22	518.64	SF	19.8	3.7	
34.1420	Q21-19	0.1586	0.1186	77.83	536.62	SF	14.8	0.4	
34.1546	Q21-19	0.1587	0.1179	63.70	439.20	SFC (I)	29.5	0.2	
34.1547	Q21-19	0.1585	0.1178	69.27	477.63	SF	14.9	0.5	
34.1548	Q21-19	0.1585	0.1184	64.85	447.14	SF	20.5	3.7	
34.1549	Q21-19	0.1585	0.1181	78.54	541.51	SFI	20.1	2.0	
34.1550	Q21-19	0.1586	0.1188	71.23	491.16	SF	16.0	3.7	
34.1500	Q21-19	0.1587	0.1190	65.69	452.96	SFC (I)	32.2	3.8	
34.1501	Q21-19	0.1584	0.1179	72.42	499.31	SF	33.2	1.0	
34.1502	Q21-19	0.1585	0.1181	68.39	471.52	SF	33.9	3.3	
34.1503	Q21-19	0.1587	0.1191	63.49	437.73	SF	33.6	3.7	
34.1504	Q21-19	0.1583	0.1180	72.88	502.48	SF	19.1	3.7	
34.1505	Q21-19	0.1585	0.1179	86.84	598.80	P	32.0	1.7	
34.1506	Q21-19	0.1585	0.1181	73.73	508.36	SF	26.6	3.3	
34.1507	Q21-19	0.1587	0.1191	68.21	470.29	SFC (I)	30.7	0.2	
34.1508	Q21-19	0.1584	0.1180	70.15	483.70	P	16.0	1.7	
34.1509	Q21-19	0.1584	0.1181	71.10	490.25	SF	32.6	3.6	
34.1620	Q21-90-34	0.1581	0.1186	73.29	505.36	SFC (I)			
34.1621	Q21-90-34	0.1577	0.1185	74.14	511.17	SF			
34.1622	Q21-90-34	0.1578	0.1186	68.64	473.30	SF			
34.1623	Q21-90-34	0.1577	0.1185	62.94	433.94	SF			
34.1624	Q21-90-34	0.1577	0.1185	61.87	426.59	SFC (I)			
34.1625	Q21-90-34	0.1577	0.1185	60.27	415.56	SF			
34.1626	Q21-90-34	0.1578	0.1184	67.27	463.85	SF			
34.1627	Q21-90-34	0.1578	0.1186	69.18	476.97	SFC (I)			
34.1628	Q21-90-34	0.1576	0.1183	77.65	535.38	SF			
34.1629	Q21-90-34	0.1578	0.1186	61.19	421.93	SFC (I)			
34.1778	Q21-90-42	0.1577	0.1187	64.85	447.14	SF	15.3	3.7	
34.1780	Q21-90-42	0.1578	0.1186	58.53	403.59	SF	34.5	3.5	
34.1781	Q21-90-42	0.1576	0.1186	60.21	415.12	SF			
34.1782	Q21-90-42	0.1576	0.1186	64.32	443.48	SF	29.7	2.8	
34.1783	Q21-90-42	0.1577	0.1187	64.97	448.00	SF	36.4	3.3	
34.1784	Q21-90-42	0.1574	0.1187	62.44	430.54	SF	16.8	0.8	
34.1785	Q21-90-42	0.1576	0.1185	62.44	430.54	SFC (I)	27.2	0.2	
34.1786	Q21-90-42	0.1576	0.1185	63.40	437.16	SF	34.2	3.7	
34.1787	Q21-90-42	0.1576	0.1186	59.93	413.20	SF	33.3	3.2	
34.1788	Q21-90-42	0.1578	0.1188	65.07	448.65	SF	15.4	0.3	
34.1790	Q21-90-42	0.1577	0.1185	65.07	448.65	SF	33.3	2.3	
34.1791	Q21-90-42	0.1577	0.1186	62.30	429.54	SFC (I)	17.4	3.8	
34.1792	Q21-90-42	0.1576	0.1187	61.17	421.76	SFC (I)	25.0	0.2	
34.1793	Q21-90-42	0.1577	0.1185	55.47	382.46	SFC (I)	22.8	0.2	
34.1794	Q21-90-42	0.1576	0.1184	55.81	405.47	SF	33.2	0.8	
34.1795	Q21-90-42	0.1576	0.1184	62.55	431.27	SF	28.5	6.3	
34.1797	Q21-90-42	0.1576	0.1184	72.71	501.30	SF	30.8	0.3	
34.1798	Q21-90-42	0.1577	0.1182	57.36	395.49	SFC (I)	24.8	3.8	

34.1799	Q21-90-42	0.1577	0.1182	61.65	425.06	P	30.4	3.1
34.1801	Q21-90-42	0.1576	0.1183	68.54	472.61	SFC (I)	34.3	0.2
34.1884	Q21-90-42	0.1568	0.1186	67.47	465.24	SF	19.0	1.2
34.1885	Q21-90-42	0.1570	0.1188	64.50	444.71	SFC (I)	14.8	0.0
34.1886	Q21-90-42	0.1570	0.1188	59.70	441.63	SF	26.5	0.5
34.1887	Q21-90-42	0.1570	0.1188	62.36	430.01	SF	30.4	3.1
34.1888	Q21-90-42	0.1570	0.1189	64.39	443.96	SF	21.7	0.7
34.1889	Q21-90-42	0.1570	0.1188	63.43	437.36	SF	19.4	0.5
34.1890	Q21-90-42	0.1570	0.1187	64.61	445.46	SF	25.6	0.8
34.1891	Q21-90-42	0.1570	0.1189	65.98	454.97	SF	34.7	0.3
34.1892	Q21-90-42	0.1570	0.1187	63.00	434.41	SFC (I)	18.6	0.2
34.1893	Q21-90-42	0.1570	0.1186	65.78	453.58	SF	27.3	1.8
34.1894	Q21-90-42	0.1569	0.1187	71.06	489.95	SF	27.8	0.3
34.1895	Q21-90-42	0.1568	0.1187	70.03	482.89	II	32.8	0.3
34.1896	Q21-90-42	0.1568	0.1186	65.33	450.47	SF	33.2	3.2
34.1897	Q21-90-42	0.1567	0.1186	70.20	484.01	SF	26.5	3.5
34.1898	Q21-90-42	0.1567	0.1186	59.48	410.11	SF	26.6	2.1
34.1899	Q21-90-42	0.1568	0.1185	62.76	432.79	SF	31.0	0.5
34.1900	Q21-90-42	0.1568	0.1186	60.51	417.24	SF	28.5	0.4
34.1901	Q21-90-42	0.1576	0.1185	68.27	470.73	SF	30.5	2.0
34.1902	Q21-90-42	0.1567	0.1185	57.03	393.25	SF	27.3	2.5
34.1903	Q21-90-42	0.1567	0.1186	72.61	500.68	SFC (I)	30.0	4.0
34.1981	Q21-17	0.1587	0.1182	69.78	481.15	SF		
34.1982	Q21-17	0.1587	0.1185	62.54	431.21	P		
34.1983	Q21-17	0.1586	0.1185	74.25	511.93	SF		
34.1984	Q21-17	0.1583	0.1184	73.98	510.10	SFC (I)		
34.1985	Q21-17	0.1584	0.1185	68.50	472.30	SF		
34.1986	Q21-17	0.1584	0.1184	65.96	454.76	SF		
34.1987	Q21-17	0.1585	0.1185	70.05	782.98	SFC (I)		
34.1988	Q21-17	0.1583	0.1183	70.37	485.23	SFC (I)		
34.1989	Q21-17	0.1582	0.1182	68.93	475.30	SFC (I)		
34.1990	Q21-17	0.1582	0.1184	69.77	481.04	SF		
AVERAGE				66.89	465.60			
STD. DEV.				5.87	53.34			
NUMBER OF SPECIMENS TESTED:				80				
NUMBER OF SPECIMENS WITH EXTERNAL FAILURES:				75				
SF = SURFACE FLAW:				53				
SFC = SURFACE FLAW CORNER:				21	I = INTERNAL	E = EXTERNAL		
SFI = SURFACE FLAW INCLUSION:				1				
NUMBER OF SPECIMENS WITH INTERNAL FAILURES:				5				
II = INTERNAL INCLUSION				1				
IP = INTERNAL PORE				4				

ROOM TEMPERATURE MOR SPECIMENS

Specimen Number: 34.1397

:Specimen Number: 34.1399

Specimen Number: 34.1399

Specimen Number: 34.1400

) Failure Origin:

Specimen Number: 34.1405

Specimen Number: 34.1408

Specimen Number: 34.1410

Specimen Number: 34.1954

Specimen Number: 34.1955

Specimen Number: 34.1956

Specimen Number: 34.1957

Specimen Number: 34.1960

Specimen Number: 34.1961

Specimen Number: 34.1962

Specimen Number: 34.1963

Specimen Number: 34.1964

Specimen Number: 34.1965

Specimen Number: 34.1599

Specimen Number: 34.1601

Specimen Number: 34.1602

Specimen Number: 34.1603

Specimen Number: 34.1604

Specimen Number: 34.1605

Specimen Number: 34.1717

Specimen Number: 34.1719

Specimen Number: 34.1724

Specimen Number: 34.1993

Specimen Number: 34.1997

Specimen Number: 34.2003

Specimen Number: 34.2005

1000°C MOR SPECIMENS

2004.9.2

Specimen Number: 34.1465

Specimen Number: 34.1466

Specimen Number: 34.1469

Specimen Number: 34.1526

Specimen Number: 34.1527

Specimen Number: 34.1528

Specimen Number: 34.1529

: Specimen Number: 34.1530

Specimen Number: 34.1726

Specimen Number: 34.1729

Specimen Number: 34.2021

Specimen Number: 34.2025

1100°C MOR SPECIMENS

Specimen Number: 34.1436

Specimen Number: 34.1437

Specimen Number: 34.1439

Specimen Number: 34.1475

Specimen Number: 34.1531

Specimen Number: 34.1532

Specimen Number: 34.1533

Specimen Number: 34.1534

Specimen Number: 34.1535

Specimen Number: 34.1632

Specimen Number: 34.2009

Specimen Number: 34.2012

1200°C MOR SPECIMENS

Specimen Number: 34.1426

Specimen Number: 34.1427

Specimen Number: 34.1428

Specimen Number: 34.1429

Specimen Number: 34.1430

Specimen Number: 34.1431

Specimen Number: 34.1432

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Specimen Number: 34.1433

Specimen Number: 34.1434

Specimen Number: 34.1435

Specimen Number: 34.1460

Specimen Number: 34.1461

Specimen Number: 34.1463

Specimen Number: 34.1464

Specimen Number: 34.1536

Specimen Number: 34.1537

Specimen Number: 34.1537

Specimen Number: 34.1538

Specimen Number: 34.1539

Specimen Number: 34.1540

Specimen Number: 34.1510

Specimen Number: 34.1511

Specimen Number: 34.1512

Specimen Number: 34.1513

: Specimen Number: 34.1514

Specimen Number: 34.1515

Specimen Number: 34.1521

Specimen Number: 34.1522

Specimen Number: 34.1523

Specimen Number: 34.1524

Specimen Number: 34.1606

Specimen Number: 34.1608

Specimen Number: 34.1609

Specimen Number: 34.1610

Specimen Number: 34.1612

Specimen Number: 34.1613

: Specimen Number: 34.1614

Specimen Number: 34.1615

: Specimen Number: 34.1653

Specimen Number: 34.1772

Specimen Number: 34.1774

Specimen Number: 34.1776

Specimen Number: 34.2031

1300°C MOR SPECIMENS

Specimen Number: 34.1421

Specimen Number: 34.1422

Specimen Number: 34.1423

Specimen Number: 34.1424

Specimen Number: 34.1425

: Specimen Number: 34.1541

Specimen Number: 34.1542

Specimen Number: 34.1543

Specimen Number: 34.1544

: Specimen Number: 34.1545

Specimen Number: 34.1638

Specimen Number: 34.1641

: Specimen Number: 34.1763

Specimen Number: 343.2028

1400°C MOR SPECIMENS

Specimen Number: 34.1416

Specimen Number: 34.1417

Specimen Number: 34.1418

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Specimen Number: 34.1419

Allison

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Specimen Number: 34.1420

Specimen Number: 34.1546

: Specimen Number: 34.1547

Specimen Number: 34.1548

Specimen Number: 34.1549

Specimen Number: 34.1550

: Specimen Number: 34.1500

Specimen Number: 34.1501

Specimen Number: 34.1502

Specimen Number: 34.1503

Specimen Number: 34.1505

Specimen Number: 34.1506

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Specimen Number: 34.1507

Specimen Number: 34.1508

Specimen Number: 34.1509

Specimen Number: 34.1620

Specimen Number: 34.1622

Specimen Number: 34.1624

Specimen Number: 34.1625

Specimen Number: 34.1626

Specimen Number: 34.1627

Specimen Number: 34.1628

Specimen Number: 34.1629

Specimen Number: 34.1795

Specimen Number: 34.1799

Specimen Number: 34.1895

: Specimen Number: 34.1982

Specimen Number: 34.1983

Specimen Number: 34.1984

Specimen Number: 34.1985

: Specimen Number: 34.1987

: Specimen Number: 34.1988

APPENDIX II

**FAST FRACTURE TENSILE TESTING OF BUTTON-HEAD SPECIMENS IN AIR AT
SOUTHERN RESEARCH INSTITUTE FROM 25°C TO 1400°C**

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT ROOM TEMPERATURE (70°F)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, GPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
76A	60.66	418.22	46.37	319.72	0.0013	IP	21-90-56	80/20	Failure 21.59 mm from center of specimen
64A	70.17	483.82	47.79	329.51	0.0015	IP	21-90-56	80/20	Failure 25.24 mm from center of specimen
66B	44.17	304.52	44.68	308.07	0.0010	II	21-90-56	80/20	Failure 13.97 mm from center of specimen
68A	60.94	420.18	44.46	306.55	0.0014	II	21-90-56	80/20	Failure 24.63 and 32.00 mm from center of specimen
93A	51.89	357.75	46.61	321.38	0.0011	IP	21-90-72	80/20	Failure 19.05 mm from center of specimen
103B	73.36	505.80	46.55	320.96	0.0016	IP	21-90-72	80/20	Failure 24.13 mm from center of specimen
83B	53.48	368.76	47.32	326.27	0.0011	IP	21-90-72	80/20	Failure 8.89 mm from center of specimen
90B	57.99	399.85	44.41	306.21	0.0013	II	21-90-72	80/20	Failure 14.48 mm from center of specimen
233B	79.35	547.08	46.69	321.93	0.0017	II(O)	21-25-91	80/20	Failure 37.10 mm from center of specimen
308B	54.92	378.66	44.84	309.17	0.0012	II	21-25-91	80/20	Failure 21.34 mm from center of specimen
159B	58.43	402.84	45.55	314.07	0.0013	II	21-25-91	80/20	Failure 10.16 mm from center of specimen
327B	61.49	423.94	47.78	329.44	0.0013	II	21-25-91	80/20	Failure 19.81 mm from center of specimen
325B	47.66	328.59	47.64	328.48	0.0010	II	21-25-91	80/20	Failure 13.72 mm from center of specimen
229A	62.00	427.49	45.60	314.41	0.0013	II	21-25-91	80/20	Failure 9.40 mm from center of specimen
324B	76.49	527.40	45.22	311.79	0.0017	II	21-25-91	80/20	Failure 2.29 mm from center of specimen
96A	86.44	596.00	44.97	310.07	0.0019	IP	21-25-91	80/20	Failure 10.16 mm from center of specimen
325A	56.04	386.40	46.82	322.82	0.0012	II	21-25-91	80/20	Failure 14.73 mm from center of specimen
168A	56.24	387.78	47.12	324.89	0.0012	II	21-4-91	80/20	Failure 5.08 mm from center of specimen
174A	74.88	516.28	45.28	312.21	0.0017	II	21-4-91	80/20	Failure 16.00 mm from center of specimen
348A	45.32	312.47	45.40	313.03	0.0010	II	21-4-91	80/20	Failure 15.24 mm from center of specimen
72A	55.51	382.76	46.27	319.03	0.0012	II	21-4-91	80/20	Failure 0.51 mm from center of specimen
167B	40.11	276.59	47.42	326.96	0.0008	SF	21-4-91	80/20	Failure 22.61 mm from center of specimen
236B	64.87	447.27	45.88	316.34	0.0014	II	21-4-91	80/20	Failure 3.05 mm from center of specimen
177B	53.53	369.08	45.77	315.58	0.0012	II	21-4-91	80/20	Failure 29.72 mm from center of specimen
182A	71.18	490.78	46.04	317.45	0.0015	II	21-4-91	80/20	Failure 23.62 mm from center of specimen
337B	57.30	395.05	45.10	310.96	0.0013	II	21-4-91	80/20	Failure 25.15 mm from center of specimen
182B	55.21	380.65	44.87	309.38	0.0012	II	21-4-91	80/20	Failure 14.73 mm from center of specimen
182A	71.18	490.78	46.04	317.45	0.0015	II	21-4-91	80/20	Failure 23.62 mm from center of specimen

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT ROOM TEMPERATURE (70°F) (Continued)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, GPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
337B	57.30	395.05	45.10	310.96	0.0013	II	21-4-91	80/20	Failure 25.15 mm from center of specimen
182B	55.21	380.65	44.87	309.38	0.0012	II	21-4-91	80/20	Failure 14.73 mm from center of specimen
372B	54.69	377.09	47.13	324.96	0.0012	II	21-16-91	80/20	Failure 12.70 mm from center of specimen
363A	45.06	310.66	48.10	331.65	0.0010	II	21-16-91	80/20	Failure 17.78 mm from center of specimen
371B	64.20	442.62	46.01	317.24	0.0014	II	21-16-91	80/20	Failure 22.10 mm from center of specimen
372A	60.13	414.58	45.78	315.65	0.0013	II	21-16-91	80/20	Failure 13.72 mm from center of specimen
370A	63.00	434.41	46.07	317.65	0.0014	II	21-16-91	80/20	Failure 11.94 mm from center of specimen
369B	65.45	451.26	46.76	322.41	0.0014	II	21-16-91	80/20	Failure 7.87 mm from center of specimen
363B	48.70	335.81	46.61	321.38	0.0011	II	21-16-91	80/20	Failure 3.30 mm from center of specimen
368A	70.62	486.95	46.37	319.72	0.0015	II	21-16-91	80/20	Failure 5.08 mm from center of specimen
276A	50.27	346.62	46.77	322.48	0.0011	II	21-16-91	80/20	Failure 8.38 mm from center of specimen
282A	52.08	359.09	46.55	320.96	0.0011	II	21-16-91	80/20	Failure 22.10 mm from center of specimen
286A	60.00	413.71	47.17	325.24	0.0013	II	21-16-91	80/20	Failure 17.02 mm from center of specimen
291A	55.62	383.52	47.13	324.96	0.0012	II	21-16-91	80/20	Failure 19.56 mm from center of specimen
366B	61.11	421.32	46.91	323.44	0.0013	II	21-16-91	80/20	Failure 15.75 mm from center of specimen
360A	59.68	411.51	45.42	313.17	0.0011	II	21-16-91	80/20	Failure 19.56 mm from center of specimen
298A	46.55	320.98	47.17	325.24	0.0010	II	21-16-91	80/20	Failure 4.32 mm from center of specimen
273A	63.66	438.94	45.73	315.31	0.0014	SF(MACH.)	21-16-91	80/20	Failure 4.06 mm from center of specimen
362B	49.00	337.86	46.30	319.24	0.0011	II	21-16-91	80/20	Failure 14.73 mm from center of specimen
291B	60.83	419.42	46.18	318.41	0.0013	II	21-16-91	80/20	Failure 20.32 mm from center of specimen
366A	59.19	408.08	47.14	325.03	0.0013	II	21-16-91	80/20	Failure 18.80 mm from center of specimen
279B	56.99	392.95	47.67	328.68	0.0012	II	21-16-91	80/20	Failure 9.14 mm from center of specimen
297B	53.62	369.68	47.61	328.27	0.0011	II	21-16-91	80/20	Failure 5.84 mm from center of specimen
292A	59.32	408.99	48.00	330.96	0.0012	SI	21-16-91	80/20	Failure 8.38 mm from center of specimen
274B	64.46	444.42	47.84	329.86	0.0013	II	21-16-91	80/20	Failure 21.59 mm from center of specimen
274A	54.21	373.74	45.85	316.14	0.0012	II	21-16-91	80/20	Failure 12.19 mm from center of specimen
373A	56.12	386.95	45.55	314.07	0.0012	II	21-16-91	80/20	Failure 8.89 mm from center of specimen
370B	55.70	384.03	45.70	315.10	0.0012	SF	21-16-91	80/20	Failure 19.30 mm from center of specimen
369A	70.78	488.00	46.35	319.58	0.0015	II	21-16-91	80/20	Failure 10.16 mm from center of specimen

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT ROOM TEMPERATURE (70°F) (Continued)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, GPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
368B	67.43	464.92	45.30	312.34	0.0015	II	21-16-91	80/20	Failure 21.34 mm from center of specimen
374B	57.22	394.51	45.41	313.10	0.0012	II	21-16-91	80/20	Failure 7.11 mm from center of specimen
373B	56.70	390.93	46.27	319.03	0.0012	II(O)	21-16-91	80/20	Failure 30.48 mm from center of specimen
516A	82.24	567.06	46.17	318.34	0.0018	SF	910124	80/20	Failure 24.38 mm from center of specimen
516B	88.65	611.23	45.32	312.48	0.0014	SI	910124	80/20	Failure 22.10 mm from center of specimen
459B	63.64	438.77	46.92	323.51	0.0019	SF	910118	80/20	Failure 27.18 mm from center of specimen
Average:	56.57	390.05	43.49	299.85					
Standard Deviation:	17.30	119.26	11.08	76.40					
104A	>69.55	>479.57	44.29	305.38	>0.0016	Head failure	900517		Broken in Handling
243B	>54.05	>372.70	45.90	316.48	>0.0012	Head failure	21-25-91		
163B	>64.57	>445.21	46.13	318.07	>0.0014	Head failure	21-4-91		
229B	>70.82	>488.33	45.21	311.72	>0.0016	Head failure	21-25-91		
142B	>64.79	>446.74	46.04	317.45	>0.0014	Head failure	21-25-91		
166B	>70.72	>487.66	45.19	311.59	>0.0016	Head failure	21-4-91		
179A	>66.07	>455.56	44.00	303.38	>0.0015	Head Failure	21-4-91		
532B	>64.34	>443.65	44.68	308.07	>0.0015	Head Failure	910124		
92B									
SF - SURFACE FLAW II - INTERNAL INCLUSION IP - INTERNAL PORE									

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1000°C (1832°F)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
105A	67.00	461.94	38.80	267.53	0.0019	SF	21-90-72	80/20	Failure 26.67 and 26.67 mm from center of specimen
95B	68.14	469.84	39.34	271.25	0.0018	IP	21-90-72	80/20	Failure 17.78 and 24.89 mm from center of specimen
121B	65.55	451.96	41.89	288.83	0.0016	SF	900517	80/20	Failure 27.18 mm from center of specimen
122A	75.64	521.50	43.16	297.59	0.0017	SF	900517	80/20	Failure 13.72 and 25.40 mm from center of specimen
125A	61.48	423.87	42.19	290.90	0.0015	II	900517	80/20	Failure 29.72 mm from center of specimen
125B	38.42	264.93	42.87	295.59	0.0009	SF	900517	80/20	Failure 24.15 mm from center of specimen
124B	69.97	482.46	42.78	294.97	0.0016	II	900517	80/20	Failure 7.11 mm from center of specimen
123A	72.23	498.01	41.89	288.83	0.0018	SF	900517	80/20	Failure 28.70 and 24.13 mm from center of specimen
115A	34.82	240.05	43.24	298.14	0.0008	IP	900517	80/20	Failure 29.21 mm from center of specimen
118B	65.55	451.97	42.51	293.11	0.0016	II	900517	80/20	Failure 29.21 and 7.62 mm from center of specimen
651B	35.28	243.23	43.57	300.42	0.0008	IP	910311	60/40	Failure 20.32 mm from center of specimen
652A	43.49	299.88	43.57	300.42	0.0010	SI	910311	60/40	Failure 9.40 mm from center of specimen
200B	70.33	484.90	43.75	301.66	0.0016	II	21-4-91	80/20	Failure 16.76 mm from center of specimen
207A	86.65	597.43	45.59	314.34	0.0019	II	21-4-91	80/20	Failure 27.94, 13.97, and 23.62 mm from center of specimen
610A	44.71	308.30	45.46	313.45	0.0010	SF	910305	60/40	Check specimen
608A	43.20	297.87	45.45	313.38	0.0010	II	910305	60/40	Failure 17.78 mm from center of specimen
609B	38.01	262.04	51.84	357.44	0.0008	SF	910305	60/40	Failure 5.08 mm from center of specimen
493B	45.15	311.27	47.77	329.37	0.0010	II	910121	80/20	Failure 29.21 mm from center of specimen
498A	31.70	218.59	47.7	328.89	0.0007	SF	910121	80/20	Failure 15.75 mm from center of specimen
489A	43.12	297.33	48.55	334.75	0.0009	SF	910121	80/20	Failure 2.54 mm from center of specimen
Average:	55.02	379.37	44.10	304.04					
Standard Deviation:	16.67	114.97	3.11	21.47					

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1100°C (2012°F)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
653B	43.35	298.93	37.62	259.39	0.0012	IP	910311	60/40	Failure 24.40 mm from center
659A	51.08	352.21	41.68	287.38	0.0013	SF	910311	60/40	Failure 11.68 mm from center
656A	37.20	256.49	37.94	261.60	0.0010	SF	910311	60/40	Failure 29.21 mm from center
652B	37.10	255.79	38.92	268.35	0.0010	SF	910311	60/40	Failure 29.46 mm from center
654B	49.22	339.37	44.07	303.86	0.0011	IP	910311	60/40	Failure 30.48 mm from center
658A	57.34	395.35	38.56	265.87	0.0015	SF	910311	60/40	Failure 14.99 mm from center
653A	45.38	312.90	36.03	248.43	0.0013	SF	910311	60/40	Failure 31.24 mm from center
654A	56.72	391.11	33.45	230.64	0.0015	SF	910311	60/40	Failure 23.37 mm from center
655A	38.29	263.98	42.08	290.14	0.0009	SF	910311	60/40	Failure 23.88 mm from center
658B	52.97	365.23	44.70	308.21	0.0012	II	910311	60/40	Failure 19.05 mm from center
655B	45.16	311.38	43.67	301.10	0.0010	SI	910311	60/40	Failure 13.21 mm from center
657B	51.64	356.06	40.83	281.52	0.0013	IP	910311	60/40	Failure 30.99 mm from center
657A	50.74	349.84	37.97	261.80	0.0013	SF	910311	60/40	Failure 28.45 mm from center
656B	29.20	201.33	43.01	296.55	0.0007	IP	910311	60/40	Failure 30.48 mm from center
338A	61.03	420.80	39.84	274.70	0.0016	II	21-4-91	80/20	Failure 12.45 mm from center
519B	31.24	215.39	46.09	317.79	0.00066	SF	910124	80/20	Failure 2.54 mm from center
479B	20.19	139.18	50.85	350.61	0.0004	SF	910118	80/20	Failure 22.86 mm from center
456B	36.88	254.30	44.3	305.45	0.00084	SI	910118	80/20	Failure 10.16 mm from center
482B	46.25	318.92	44.1	304.07	0.00104	SF	910118	80/20	Failure 17.78 mm from center
84A	68.96	475.50	41.23	284.28	0.0017	SF	21-90-72	80/20	Failure 26.67 and 22.86 mm from center
Average:	45.50	313.70	41.35	285.09					
Standard Deviation:	11.71	80.73	3.98	27.41					

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1200°C (2192°F)

Specimen ID	Strength, psi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
97A	54.71	377.21	38.22	263.53	0.0015	II	21-90-72	80/20	Failure 1.27 mm from center
234A	75.74	522.22	43.77	301.79	0.0018	II	21-25-91	80/20	Mutiple breaks
118A	40.46	278.96	44.42	306.28	0.0009	SF	900517	80/20	Failure 19.81 mm from center
115B	54.53	376.01	45.80	315.79	0.0012	SI	900517	80/20	Failure 9.65 mm from center
110B	66.30	457.14	41.49	286.07	0.0016	II	900517	80/20	Failure 14.99 and 23.67 mm from center
112A	64.02	441.42	39.85	274.77	0.0016	II	900517	80/20	Failure 25.91 mm from center
104B	64.22	442.80	41.36	285.18	0.0016	SI	900517	80/20	Failure 14.73 and 27.18 mm from center of specimen
107A	58.51	403.44	40.13	276.70	0.0015	SF	900517	80/20	Failure 27.18 mm from center
116B	60.45	416.80	39.90	275.11	0.0016	II	900517	80/20	Failure 16.51 mm from center
113B	58.51	403.44	39.48	272.21	0.0015	SF	900517	80/20	Failure 23.88 mm from center
109A	53.80	370.95	39.22	270.42	0.0014	II	900517	80/20	Failure 15.75 mm from center
114A	53.12	366.24	41.88	288.76	0.0013	SF	900517	80/20	Failure 24.38 mm from center
108B	55.48	382.52	37.86	261.04	0.0015	SF	900517	80/20	Failure 24.89 mm from center
472B	47.24	325.74	40.32	278.01	0.0012	SF	910118	80/20	Failure 2.54 mm from center
477B	48.24	332.64	45.91	316.55	0.0010	II	910118	80/20	Failure 12.70 mm from center
478A	39.91	275.20	43.09	297.11	0.0009	SF	910118	80/20	Failure 7.62 mm from center
461A	46.95	323.71	44.61	307.59	0.0011	SF	910118	80/20	Failure 4.06 mm from center
477A	39.60	273.04	44.11	304.14	0.0009	SF	910118	80/20	Failure 33.53 mm from center
468A	51.75	356.78	44.51	306.90	0.0012	II	910118	80/20	Failure 0.00 mm from center
455B	33.30	229.60	44.78	308.76	0.0008	IP	910118	80/20	Failure 15.75 mm from center
467B	52.94	365.05	46.11	317.93	0.0012	SF	910118	80/20	Failure 26.42 mm from center
448B	34.14	235.36	42.00	289.59	0.0008	IP	910118	80/20	Failure 27.69 mm from center
462A	38.33	264.26	42.92	295.93	0.0009	II	910118	80/20	Failure 12.70 and 29.21 mm from center
459A	39.90	275.12	44.89	309.52	0.0009	SF	910118	80/20	Failure 27.94 mm from center
471B	46.06	317.58	44.59	307.45	0.0011	SF	910118	80/20	Failure 8.89 mm from center
469A	47.85	329.93	44.29	305.38	0.0011	SF	910118	80/20	Failure 27.94 mm from center
464A	47.39	326.74	46.05	317.51	0.0010	SF	910118	80/20	Failure 5.59 and 27.94 mm from center
465B	38.39	264.69	43.43	299.45	0.0009	SF	910118	80/20	Failure 29.21 mm from center

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1200°C (2192°F)

Specimen ID	Strength, psi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
475A	25.16	173.49	46.27	319.03	0.0005	SF	910118	80/20	Failure 27.94 mm from center
480A	46.70	322.00	46.11	317.93	0.0010	SF	910118	80/20	Failure 27.94 and 12.70 mm from center
466A	50.95	351.27	44.20	304.76	0.0012	IP	910118	80/20	Failure 25.91 mm from center
451B	35.43	244.27	39.94	275.39	0.0009	SF	910118	80/20	Failure 24.13 mm from center
534B	40.63	280.12	43.30	298.55	0.0010	SF	910124	80/20	Failure 28.45 mm from center
517A	31.67	218.37	39.77	274.21	0.0008	SF	910124	80/20	Failure 35.05 mm from center
515B	44.76	308.63	45.33	312.55	0.0010	SF	910124	80/20	Failure 27.94 and 16.76 mm from center
529A	43.28	298.39	44.84	309.17	0.0010	SF	910124	80/20	Failure 24.13 mm from center
520B	44.94	309.86	42.48	292.90	0.0011	SF	910124	80/20	Failure 25.91 mm from center
531A	49.02	338.01	46.41	320.00	0.0011	SF	910124	80/20	Failure 33.02 mm from center
513B	43.80	302.01	45.00	310.28	0.0010	SF	910124	80/20	Failure 22.10 mm from center
513A	46.95	323.72	42.31	291.73	0.0011	II	910124	80/20	Failure 4.32 mm from center
520A	45.35	312.66	43.51	300.00	0.0011	SF	910124	80/20	Failure 24.13 mm from center
518B	45.34	312.63	42.88	295.66	0.0011	SF	910124	80/20	Failure 24.94 and 10.16 mm from center
518B	45.34	312.63	42.88	295.66	0.0011	SF	910124	80/20	Failure 24.94 and 10.16 mm from center
530A	40.91	282.04	44.38	306.00	0.0009	SF	910124	80/20	Failure 25.40 mm from center
484B	45.65	314.77	44.40	306.14	0.0010	SF	910121	80/20	Failure 21.59 mm from center
482A	43.52	300.08	42.83	295.31	0.0010	SF	910121	80/20	Failure 33.78 mm from center
484A	34.30	236.50	44.15	304.41	0.0008	SF	910121	80/20	Failure 15.24 mm from center
492A	30.87	212.85	43.68	301.17	0.0007	II	910121	80/20	Failure 21.84 and 27.43 mm from center
472A	42.57	293.54	44.81	308.96	0.0010	SF	910121	80/20	Failure 29.46 mm from center
491A	43.43	299.46	42.78	294.97	0.0010	SF	910121	80/20	Failure 9.65 mm from center
490A	44.85	309.23	43.34	298.83	0.0010	SF	910121	80/20	Failure 23.62 mm from center
481A	47.25	325.77	46.51	320.69	0.0010	SF	910121	80/20	Failure 30.48 mm from center
495B	45.69	315.05	45.91	316.55	0.0010	SF	910121	80/20	Failure 29.21 mm from center
496A	36.30	250.29	42.11	290.35	0.0009	IP	910121	80/20	Failure 25.40 mm from center
489A	35.20	242.72	43.48	299.79	0.0008	SF	910121	80/20	Failure 22.86 mm from center
481B	40.96	282.40	42.69	294.35	0.0010	SF	910121	80/20	Failure 29.46 mm from center
599B	49.22	339.38	41.61	286.90	0.0012	II	910305	60/40	Failure 2.54 mm from center of specimen

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1200°C (2192°F)

Specimen ID	Strength, psi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
604A	28.47	196.29	39.48	272.21	0.0007	SF	910305	60/40	Failure 29.46 mm from center of specimen
602A	46.45	320.28	45.18	311.52	0.0010	SO	910305	60/40	Failure 12.70 mm from center of specimen
596B	43.62	300.77	41.93	289.11	0.0010	SF	910305	60/40	Failure 29.97 mm from center of specimen
601B	47.55	327.84	42.06	290.00	0.0012	II	910305	60/40	Failure 15.24 mm from center of specimen
601A	41.51	286.23	40.82	281.45	0.0010	II	910305	60/40	Failure 3.81 mm from center of specimen
595B	50.95	351.27	45.20	311.65	0.0012	II	910305	60/40	
600B	38.22	263.52	45.88	316.34	0.0009	IP	910305	60/40	Failure 27.94 mm from center of specimen
618A	36.04	248.49	42.5	293.04	0.0009	SF	910305	60/40	Failure 27.94 mm from center of specimen
611B	36.75	253.37	41.72	287.66	0.0009	SF	910305	60/40	Failure 27.94 mm from center of specimen
618B	39.89	275.02	45.33	312.55	0.0009	SF	910305	60/40	Failure 12.19 mm from center of specimen
607B	48.55	334.75	43.81	302.07	0.0011	IP	910305	60/40	Failure 0.51 mm from center of specimen
613A	42.43	292.53	38.89	268.15	0.0011	SF	910305	60/40	Failure 28.45 mm from center of specimen
614A	37.00	255.12	42.45	292.69	0.0009	SF	910305	60/40	Failure 20.32 mm from center of specimen
615B	42.16	290.67	44.1	304.07	0.0010	SF	910305	60/40	Failure 24.40 mm from center of specimen
605A	44.29	305.37	41.53	286.35	0.0011	II	910305	60/40	Failure 10.16 mm from center of specimen
Average:	42.84	295.37	40.84	281.59					
Standard Deviation:	13.39	92.32	9.92	68.40					

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1300°C (2372°F)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
94B	44.90	309.61	39.13	269.80	0.0013	IP	21-90-72	80/20	Failure 21.34 mm from center of specimen
112B	59.79	412.25	42.01	289.66	0.0015	IP	900517	80/20	Failure 31.50 mm from center of specimen
111A	41.71	287.59	41.88	288.76	0.0010	SF	900517	80/20	Failure 10.16 mm from center of specimen
108A	50.84	350.53	43.76	301.73	0.0012	II	900517	80/20	Failure 21.34 mm from center of specimen
110A	52.69	363.28	44.13	304.28	0.0012	II	900517	80/20	Failure 3.81 mm from center of specimen
107B	44.40	306.10	42.19	290.90	0.0012	IP	900517	80/20	Failure 24.89 mm from center of specimen
331B	58.12	400.70	44.80	308.90	0.0012	II	21-4-91	80/20	Failure 24.89 mm from center of specimen
191B	61.24	422.26	46.71	322.07	0.0014	SF	21-4-91	80/20	Failure 27.94 mm from center of specimen
217B	59.09	407.43	42.24	291.24	0.0014	IP	21-4-91	80/20	Failure 1.52 mm from center of specimen
332A	53.83	371.15	44.41	306.21	0.0012	II	21-4-91	80/20	Failure 5.33 mm from center of specimen
184A	65.27	450.04	42.90	295.80	0.0016	II	21-4-91	80/20	Failure 10.92 mm from center of specimen
192A	55.62	383.49	43.46	299.66	0.0013	II	21-4-91	80/20	Failure 13.97 mm from center of specimen
222B	72.71	501.31	45.27	312.14	0.0017	IP	21-4-91	80/20	Check specimen
184B	55.12	380.04	44.34	305.72	0.0013	SF	21-4-91	80/20	Failure 27.94 mm from center of specimen
193A	58.31	402.02	43.90	302.69	0.0014	II	21-4-91	80/20	Failure 2.54 mm from center of specimen
61B	63.40	437.17	44.39	306.07	0.0015	IP	21-90-56	80/20	Failure 5.84 mm from center of specimen
58A	52.22	360.07	43.82	302.14	0.0012	II	21-90-56	80/20	Failure 2.29 mm from center of specimen
54B	58.06	400.34	40.70	280.63	0.0014	II	21-90-56	80/20	Failure 26.67 and 3.56 mm from center of specimen
52B	61.18	421.84	40.11	276.56	0.0016	II	21-90-56	80/20	Failure 27.43 and 0.00 mm from center of specimen
494B	44.97	310.05	45.23	311.86	0.0010	SF	910121	80/20	Failure 29.21 mm from center of specimen

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1400°C (2552°F)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
67B	21.63	149.15	34.98	241.19	0.0008	SI	21-90-56	80/20	Failure 15.75 and 21.13 mm from center of specimen
172B	49.04	338.16	40.27	277.66	0.0015	II	21-4-91	80/20	Failure 21.59 mm from center of specimen
172A	42.24	291.24				SF	21-4-91	80/20	Failure 18.80 mm from center of specimen
71B	29.58	203.98	39.83	274.63	0.0010	IP	21-4-91	80/20	Failure 6.35 mm from center of specimen
178A	55.59	383.26	41.44	285.73	0.0015	II	21-4-91	80/20	Failure 3.30 and 27.69 mm from center of specimen
161B	53.39	368.10	40.40	278.56	0.0016	IP	21-4-91	80/20	Failure 5.84 mm from center of specimen
176A	59.22	408.29	40.05	276.14	0.0016	IP	21-4-91	80/20	Failure 4.32 and 24.13 mm from center of specimen
179B	51.65	356.10	41.05	283.04	0.0015	II	21-4-91	80/20	Failure 25.40 and 0.51 mm from center of specimen
175B	50.47	347.98	39.50	272.35	0.0015	IP	21-4-91	80/20	Failure 17.78 mm from center of specimen
161A	34.32	236.64	35.94	247.81	0.0012	SF	21-4-91	80/20	Failure 17.78 mm from center of specimen
334A	44.23	304.97	40.12	276.63	0.0012	II	21-4-91	80/20	Failure 20.83 mm from center of specimen
204A	61.08	421.11	43.88	302.55	0.0016	II	21-4-91	80/20	Failure 7.62 and 22.86 mm from center of specimen
206B	57.69	397.79	41.45	285.80	0.0017	IP	21-4-91	80/20	Failure 5.08 mm from center of specimen
202A	39.04	269.19	37.86	261.04	0.0012	IP	21-4-91	80/20	Failure 18.54 mm from center of specimen
186B	50.48	348.09	38.46	265.18	0.0013	II	21-4-91	80/20	Failure 8.89 mm from center of specimen
65B	49.00	337.86	41.67	287.31	0.0012	SF	21-4-91	80/20	Failure 2.54 mm from center of specimen
335B	49.50	341.31	40.91	282.07	0.0012	SI	21-4-91	80/20	Failure 2.54 mm from center of specimen
338B	49.20	339.24	45.98	317.03	0.0012	SF	21-4-91	80/20	Failure 4.06 mm from center of specimen
328B	51.07	352.15	37.65	259.60	0.0017	II	21-25-91	80/20	Failure 31.24 mm from center of specimen
232A	59.75	411.95				II	21-25-91	80/20	Failure 10.92 mm from center of specimen
157B	56.16	387.23	38.21	263.46	0.0016	SF	21-25-91	80/20	Failure 20.32 mm from center of specimen
156B	50.57	348.68	40.62	280.07	0.0014	IP	21-25-91	80/20	Failure 17.78 mm from center of specimen
158A	16.17	111.51	20.36	140.38	0.0012	IP(O)	21-25-91	80/20	Failure 16.26 mm from center of specimen
232B	26.00	179.27	36.04	248.50	0.0009	IP	21-25-91	80/20	Failure 17.78 mm from center of specimen

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1400°C (2552°F) (Continued)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
248A	56.28	388.05	38.64	266.42	0.0016	II	21-25-91	80/20	Failure 7.62 mm from center of specimen
329B	42.97	296.29	46.27	319.03	0.0010	SI	21-25-91	80/20	Failure 24.38 mm from center of specimen
159A	56.26	387.89	42.97	296.28	0.0014	II	21-25-91	80/20	Failure 1.02 mm from center of specimen
234B	52.68	363.20	40.64	280.21	0.0014	SI	21-25-91	80/20	Failure 24.38 and 13.82 mm from center of specimen
154A	25.16	173.49	31.70	218.57	0.0009	SF	21-25-91	80/20	Failure 21.08 mm from center of specimen
244A	56.80	391.62	38.18	263.25	0.0016	SI	21-25-91	80/20	Failure 2.54 mm from center of specimen
245A	50.56	348.58	37.86	261.04	0.0014	SP	21-25-91	80/20	Failure 14.48 mm from center of specimen
240B	57.83	398.75	45.34	312.62	0.0015	II	21-25-91	80/20	Failure 25.40 and 25.40 mm from center of specimen
208A	29.65	204.42	44.97	310.07	0.0009	IP	910311	60/40	Failure 5.84 mm from center of specimen
663A	26.77	184.59	36.12	249.05	0.0011	SF	910311	60/40	Failure 10.16 mm from center of specimen
660B	46.40	319.90	44.63	307.72	0.0011	II	910311	60/40	Failure 7.37 mm from center of specimen
665B	38.21	263.44	50.29	346.75	0.0011	SF	910311	60/40	Failure 2.03 mm from center of specimen
664B	40.55	279.59	40.75	280.97	0.0012	SF	910311	60/40	Failure 0.76 mm from center of specimen
661B	41.80	288.20	45.12	311.10	0.0010	SF	910311	60/40	Failure 26.16 mm from center of specimen
659B	38.38	264.64	50.11	345.51	0.0008	SF	910311	60/40	Failure 19.05 mm from center of specimen
663B	42.04	289.85	41.43	285.66	0.0012	SF	910311	60/40	Failure 12.7 mm from center of specimen
662A	43.83	302.24	46.55	320.96	0.0010	II	910311	60/40	Failure 5.08 mm from center of specimen
661A	43.96	303.10	45.83	316.00	0.0010	II	910311	60/40	Failure 12.19 mm from center of specimen
664A	43.70	301.32	46.30	319.24	0.0010	II	910311	60/40	Failure 10.92 mm from center of specimen
623B	45.50	313.73	43.38	299.11	0.0011	II	910307	60/40	Failure 1.02 mm from center of specimen
631B	42.67	294.23	44.91	309.65	0.0010	SF	910307	60/40	Failure 3.30 mm from center of specimen
633A	44.74	308.48	44.68	308.07	0.0010	SI	910307	60/40	Failure 3.81 mm from center of specimen
630A	39.08	269.42	44.77	308.69	0.0009	SF	910307	60/40	Failure 28.45 mm from center of specimen
624A	40.42	278.68	44.05	303.72	0.0009	II	910307	60/40	Failure 1.27 mm from center of specimen
628B	44.90	309.59	47.06	324.48	0.0010	II	910307	60/40	Failure 19.81 mm from center of specimen
634A	33.98	234.30	44.68	308.07	0.0008	SF	910307	60/40	Failure 17.78 mm from center of specimen
636B	27.86	192.09	41.49	286.07	0.0009	SF	910307	60/40	Failure 9.14 mm from center of specimen

MONOTONIC TENSILE STRENGTH OF PY6 SILICON NITRIDE AT 1400°C (2552°F) (Continued)

Specimen ID	Strength, Ksi	Strength, MPa	Modulus, Msi	Modulus, MPa	Strain-to Failure, in./in.	Failure Mode	Lot Number	Composition	Remarks
622A	33.22	229.02	43.87	302.48	0.0008	SF	910307	60/40	Failure 29.21 mm from center of specimen
632A	39.57	272.86	46.80	322.69	0.0009	SF	910307	60/40	Failure 4.83 mm from center of specimen
624B	47.75	329.22	41.44	285.73	0.0012	II	910307	60/40	Failure 25.40 and 17.526 mm from center of specimen
631A	39.28	270.86	48.30	333.03	0.0008	II	910307	60/40	Failure 3.05 mm from center of specimen
616A	42.05	289.90	45.20	311.65	0.0010	SF(O)	910305	60/40	Failure 31.75 mm from center of specimen
609A	30.84	212.61	43.81	302.07	0.0007	SF(O)	910305	60/40	Failure 34.29 mm from center of specimen

ROOM TEMPERATURE TENSILE TESTING OF BUTTON-HEAD SPECIMENS

90°

Specimen Number: 516A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 516B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 459B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 308B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 233B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 229A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 325B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 236B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 348A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 337B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 373B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 182A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 373A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 372B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 372A

0° Non-Reference End

90°

0° Non-Reference

90°

Specimen Number: 371B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 369A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 368B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 368A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 366B

0° Reference End

90°

0° Non-Reference

Specimen Number: 366A

0° Reference End

90°

Specimen Number: 363A 363A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 362B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 360A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 297B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 291B

0° Reference End

90°

0° Non-Reference

Specimen Number: 291A

0° Reference End

90°

Specimen Number: 286A

0° Reference End

90°

0° Non-Reference

Specimen Number: 282A

0° Reference End

90°

Specimen Number: 279A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 276A

0° Reference End

90°

0° Non-Reference

Specimen Number: 274B

0° Reference End

0° Non-Reference

90°

Specimen Number: 273A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 177B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 168A

0° Reference End

90°

0° Non-Reference

Specimen Number: 174A

0° Reference End

0° Non-Reference

90°

Specimen Number: 324B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 327B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 325A

0° Reference End

90°

0° Non-Reference

1000°C TENSILE TESTING OF BUTTON-HEAD SPECIMENS

24-5-92

90°

Specimen Number: 609B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 493B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 118B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 121B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 125B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 200B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 207A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 124B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 115A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 652A

0° Reference End

90°

0° Non-Reference

Specimen Number: 651B

0° Reference End

0° Non-Reference

1100°C TENSILE TESTING OF BUTTON-HEAD SPECIMENS

90°

Specimen Number: 608A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 498A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 479B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 482B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 456B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 579B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 338A 0° Reference End

90°

0° Non-Reference

Specimen Number: 657A

0° Reference End

0° Non-Reference

Specimen Number: 653B

0° Reference End

0° Non-Reference

90°

Specimen Number: 659A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 655A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 654B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 84A

0° Reference End

90°

0° Non-Reference

1200°C TENSILE TESTING OF BUTTON-HEAD SPECIMENS

90°

Specimen Number: 595B :

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 600B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 596B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 596A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 604A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 481A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 598B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 601B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 607B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 615B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 601A : 0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 599B

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 605A

0° Reference End

90°

0° Non-Reference

90°

Specimen Number: 596A

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Specimen Number: 161A

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