Moissanite, cubic zirconia and sapphire as alternatives to diamond in high pressure anvil cells.

The most common gems used as alternatives to diamonds in high pressure anvil cells are moissanite, cubic zirconia and sapphire. These gems are useful in situations where diamonds cannot really be used.

For example, it is difficult to study the compressional behaviour of diamond itself in diamond anvil cells, since the signal from the anvils seriously interfere with that from the diamond sample. Of course, this is also the case whenever the measured properties are close to those of diamond.

	Moissanite	Sapphire	Cubic Zirconia
Composition	SiC	Al2O3	ZrO2
Impurities (mol%)	-	-	15Y2O3
Crystal Structure	$P6_3mc$	R3C (D^6_{3d}) SiC-6H	Cubic
Density (g cm^{-3})	3.217	3.97	5.6
Hardness (Knoop)	3000	2000	1370
Hardness (Mohr)	9.25	9.0	8.5
Bulk Modulus (GPa)	224; 267-335	253-255	-
Young's modulus	-	348.6	-
Melting point (°C)	2700	2105	2680
Thermal conductivity (W m^{-1} K^{-1} at 293K)	140-500	25	1.8
Thermal expansion (10^{-6})	2.8	7.8	10-16.6
Stable T (°C)			
In air	1700	1700	2400
In vacuum	2000		
Refractive index, n	2.648, 2.6911	1.73	2.15-2.18
Birefringence	0.043		
Dispersion	0.104		
Transparency	> 425 nm	< 5.5 um	< 6.9 um
Highest P (GPa) (up to 2002)	58.7	25.8	16.7
Year achieved	2001	1995	1995

Table 1: Comparison of properties of gems commonly used in high pressure anvil cells.

The table above compares the properties of these different gem anvil materials (after Xu J, Mao H K, Hemley R J, 2002 J. Phys.: Condens. Matter 14, 11549).

It is noteworthy that the highest pressures achieved to date in gem anvil cells are:

58.7 GPa for moissanite anvils
(c.f. Xu J and Mao H K 2000 Science 290, 783 and Xu J, Mao H K, Hemley R J and Hines E 2002 J. Phys.: Condens. Matter 14)

25.8 GPa for sapphire anvils, and

16.7 GPa for cubic zirconia anvils
(c.f. Xu J, Yen J, Wang Y and Huang E 1995 High Pressure Res. 15, 127).