Additive Composite

Technical Note 2018/03/a **November 2018**

Neutron Shielding with ABS/Gadolinium Oxide composites

Composites formed with gadolinium oxide (Gd_2O_3) and plastics can be prepared as filaments for 3D printing. These materials offer attractive high absorption for thermal neutrons although this shielding effect drops sharply for short wavelengths (high energies). The possibility to create precisely formed pieces and good surface finish is very attractive for some applications. The absorption is significantly higher than that of boron carbide and so allows components with smaller thicknesses to be fabricated.

Approximate attenuation factors – thermal neutrons (velocity 2200 m s^{-1}, wavelength 1.8 Å)

Wt. fraction	Vol. fraction	Thickness / mm	Att. Length (for 1/e) / mm	Attenuation	Transmission
0.7	0.266	0.15	0.032	1.07E+02	9.39E-03
0.7	0.266	0.3	0.032	1.13E+04	8.81E-05
0.7	0.266	1.0	0.032	3.29E+13	3.04E-14
0.3	0.062	0.5	0.137	3.84E+01	2.60E-02
0.3	0.062	1.0	0.137	1.48E+03	6.77E-04

Notes

- For other thermal energies (longer wavelengths), the attenuation scales approximately as 1/velocity.
- For some applications it may be useful to incorporate heavy metals as an integral component to protect against gamma radiation that is either external or created by neutron absorption. Tungsten composites can be incorporated in shielding.
- For high energy radiation, moderation of neutrons in the plastic can be a significant advantage but specific neutronic calculations may be needed. This can shift the average neutron energy by means of multiple scattering.