PEN as Self Vetoing Structural Material

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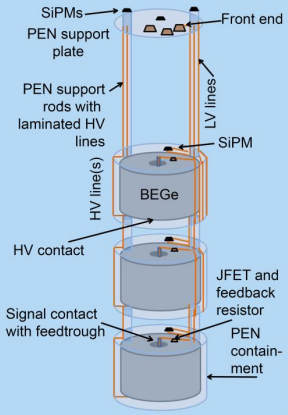
HPGe Detectors



PEN has been reported to scintillate [1] and it has favorable structural properties.[2]
PEN is suitable for signal transmission [3] and has been shown to be appropriate for HV cables.[4]

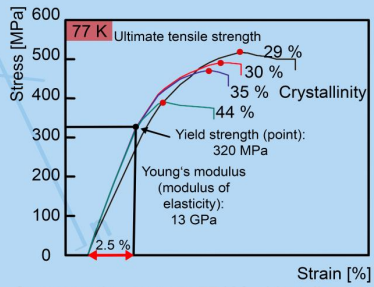
⇨ Use PEN as self vetoing structural material:

- Containment for HPGe detectors
- Holder systems
- Laminate PEN for signal transmission
  ⇨ No cables necessary [3]
- Read out scintillation light from structural materials with SiPMs

Comparison of tensile strength:

	Yield Strength[MPa]	Young's Modulus[GPa]
PEN	>200	5-13
PET	55	~1
Copper	~70	130
Kapton	85	2.5

Mechanical Properties



Stress-strain curves at 77 K for biaxially streched PEN films with various degrees of crystallinity.[2]

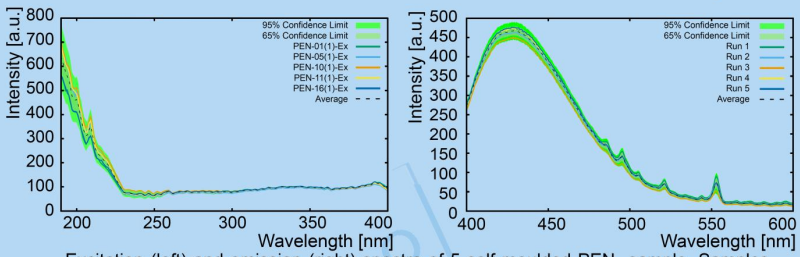
	^{40}K [Bq/kg]	^{226}Ra [mBq/kg]	^{228}Th [mBq/kg]	^{235}U [mBq/kg]
PEN 8050	1.0±0.4	< 0.11	< 0.13	< 0.05
PEN 8065	1.6±0.4	0.25±0.05	0.23±0.05	< 0.07

Granules were measured with gamma screening by Matthias Laubenstein. Recently, PEN has been used for low background cables and capacitors. [3,4]

Moulding of PEN

- Purchased PEN granules from Tejin DuPont
- Moulded our own PEN tiles at the Frauenhofer Institute and TU Dortmund
- Machining the tiles afterwards to meet our conditions

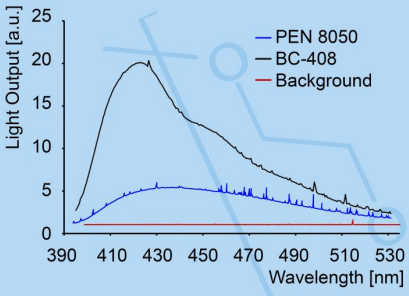
Excitation & Emission Spectra



Excitation (left) and emission (right) spectra of 5 self moulded PEN sample. Samples were produced at TU Dortmund. Excitation spectra were measured at 450 nm. Emission spectra were taken with samples excited using 360 nm light. Measurements were done at Lancaster University.[5]

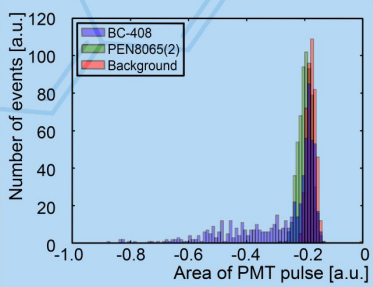
Done so far

Response to Radiation



Pilot test:
Comparison of light emitted by PEN and BC-408 samples, irradiated with ^{106}Ru source. Measurements were taken with CCD based split spectrometer.
The test shows that PEN scintillates, but the light yield is less than for BC-408.

Excitation measurements indicate that light with < 200 nm wavelength is efficiently shifted to ~430 nm.
⇨ **PEN containment may be used as active LAr veto utilizing 128 nm LAr scintillation light.**



PEN light yield claimed by [1] could be reproduced by replicating the original setup using large surface PMT. The difference in light collection efficiency observed in the spectrometer setup is attributed to lower attenuation length in PEN. Measurements were made at Lancaster University. [5]

Next Steps - Outlook

- Electropolish moulds for a better surface quality of the PEN tiles
- Flexibility by making our own moulds
- Temperature dependent light yield measurements
- Simulations of PEN containment for HPGe detectors
- Test light shifting properties of PEN with scintillation light of LAr

References

[1] H. Nakamura et al., EPL 95(2011)22001
[2] Yano O, Yamaoka H et al., Prog. Polym. Sci. 20(1995)585
[3] C. Brofferio et al., NIM A 718(2013)211
[4] C. O'Shaugnessy et al., EPJC 73(2013)2445
[5] C. Hayward, Lancaster University, in private communication