Different contact metallizations in detector based on a thick 4H-SiC epitaxial layer

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Introduction

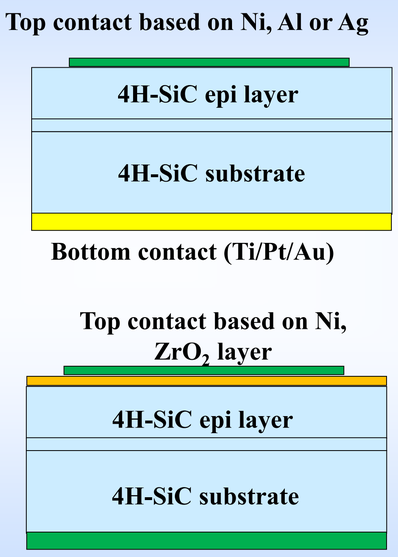
Detectors based on 4H-SiC (Silicon Carbide) are very perspective due to:

- high breakdown voltage (4×10^6 V/cm)
- electron mobility of about 900 $cm^2V^{-1}s^{-1}$
- high electron saturation drift velocity (2×10^7 cms^{-1})
- band gap energy of 3.26 eV
- operation at increased temperature up to 500 °C
- good radiation hardness

Detector material

- 100 µm thick nitrogen-doped 4H–SiC layer grown by CREE
- Doping concentrations about 2×10^{14} cm^{-3}
- 4H-SiC n^{++} substrate (350 µm thick)
- 0.5 µm buffer layer n^+-SiC with concentration 1×10^{18} cm^{-3}

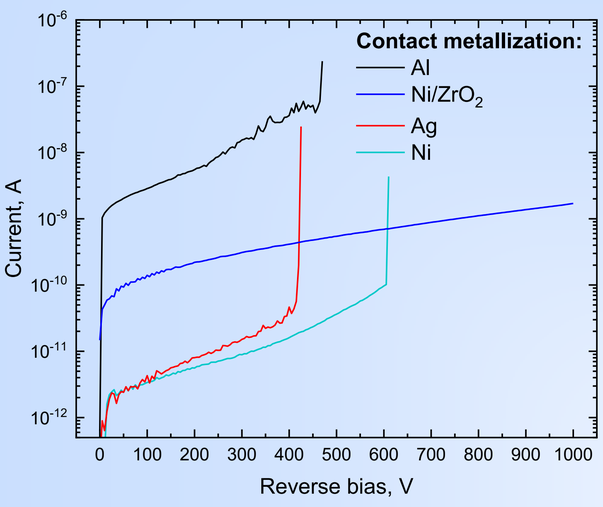
Detector structures



Experimental methods

- The current-voltage characteristics were measured at RT using a custom-built picoampermeter/ voltage source. The measurement was performed up to 1 kV.
- The detector was connected to the spectrometric setup consisting of a charge sensitive preamplifier CAEN A1422, a multi-channel digital analyzer CAEN HEXAGON with high voltage source for detector connection and a personal computer.
- As a source of α-particle radiation, we used the radioisotopes $^{239}Pu^{238}Pu^{244}Cm$, which produce monoenergetic α–particles with the energy from 5157 keV up to 5805 keV

Typical current-voltage characteristics



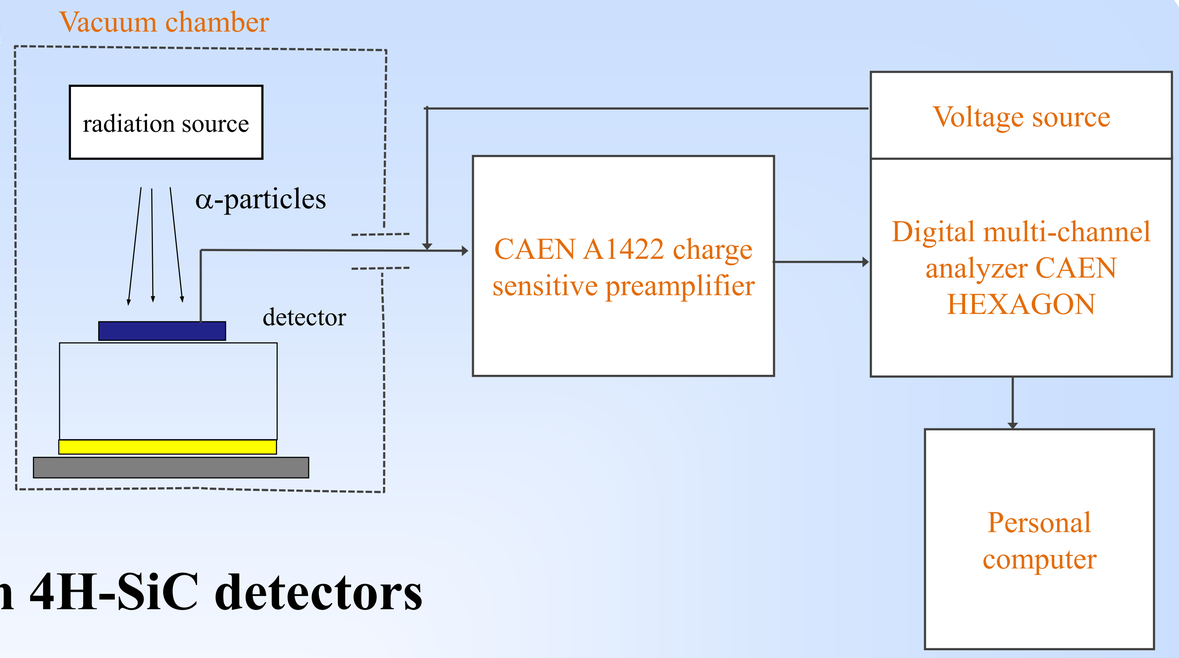
α-particles generated by $^{239}Pu^{238}Pu^{244}Cm$ radioisotopes

Radioisotope	^{239}Pu	^{238}Pu	^{244}Cm
Energy 1 (keV)	5156.56	5499.77	5804.77
Intensity (%)	70.79	71.04	76.7
Energy 2 (keV)	5143.82	5456.30	5762.65
Intensity (%)	17.14	28.85	23.30
Energy 3 (keV)	5105.81	-	-
Intensity (%)	11.87	-	-

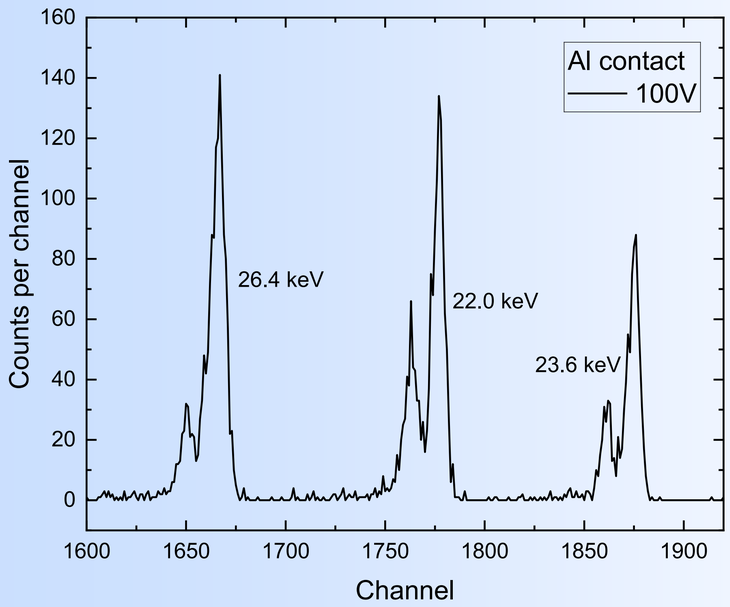
$$W = \sqrt{\frac{2\varepsilon_s(V_{bi} - V)}{qN_D}}$$

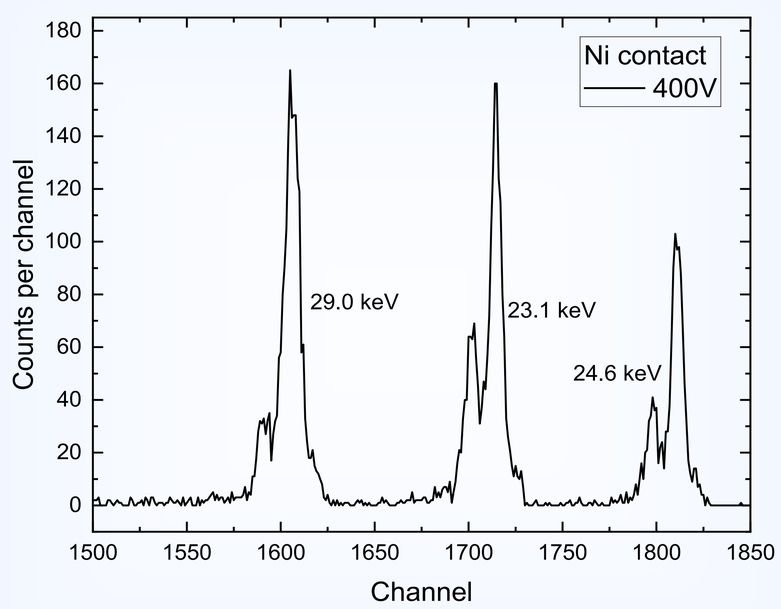
W – deletion width;
V – operational bias;
N_D – impurity concentration;

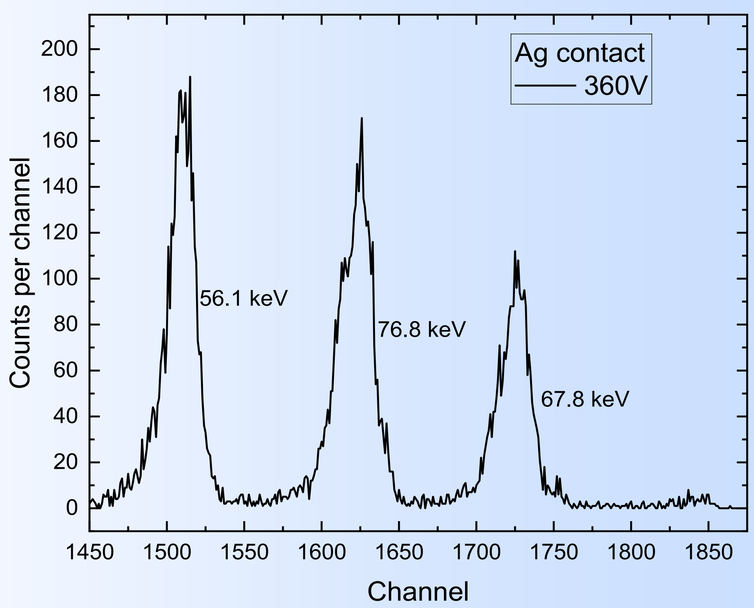
Spectrometric set-up for detection of α-particles

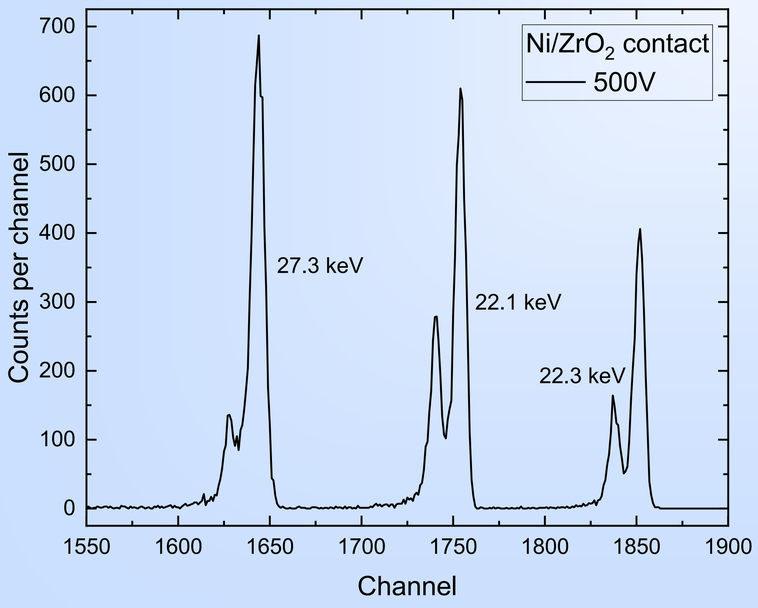


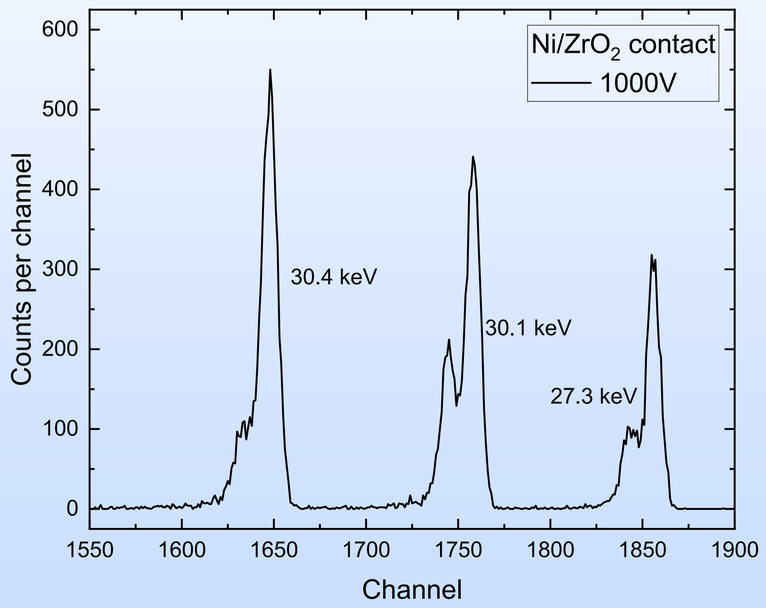
Measured α-spectra with 4H-SiC detectors











Summary and Conclusion

- We prepared detectors from a 4H-SiC epitaxial layer with a thickness of 100 µm.
- On top, the circular contacts were prepared based on different metallizations like Al, Ni, and Ag. Also, ZrO_2 interlayer was used to improve detector performance.
- The current voltage characteristics were measured up to 1000 V. Structure with ZrO_2 interlayer doesn‘t show breakdown up to maximum measured voltage.
- Following the structures were connected to the spectrometric chain and used to detect of alpha particles from the triple radioisotopes ^{238}Pu ^{239}Pu ^{244}Cm. The detected alpha particles have an energy range of 5.16 MeV to 5.80 MeV.
- The best energy resolution obtained detector structure with ZrO_2 interlayer at about 20 keV. This detector was able to operated up to 1000 V of reverse bias.

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