Contribution ID: **75** Type: **not specified**

Pixelated ceramic scintillators for large-area high-resolution X-ray and gamma-ray detectors

Current detector technology used in large equipment at CERN and other collider facilities concentrates either on low energy absorption with high spatial and energy resolution (Si-strip or Ge-detectors) or on strong energy absorption with limited spatial resolution (PWO, BGO, CsI:Tl). Equipment with properties in between, i.e. medium to high energy absorption combined with relatively high spatial and energy resolution seems to be less abundant.

We propose a technology that provides strong energy absorption and high spatial resolution for pixelated scintillator detectors at a moderate price. Up till now ceramic technology for gadolinium oxisulfides (GOS) and garnets (GGAG) have been developed at the Philips Generators, Tubes and Components (GTC) business group in cooperation with Philips Research. Garnet ceramics are produced as optically transparent sticks of up to 60 mm length, with the diameter adapted to the pixel size of current SiPM detectors. A major advantage compared to single crystal growth is the larger flexibility to tailor the material composition to meet scintillator requirements. Effective Z values up to 57, photon gain values approaching 50 - 60,000 photons/MeV, energy resolution on par with high-end PET scintillators such as LSO and LYSO, and decay times much shorter than known for single-crystalline garnets have been reached. Building large-area arrays of scintillator sticks for medical imaging applications (CT and PET), including optical reflectors, is by now an established technology for Philips.

Our current research is concentrating on a deep understanding of garnet properties. In cooperation with Peter the Great St. Petersburg Polytechnic University we are working on a further optimization of this material class. Determination of the nature of deep traps, quantitative evaluation of trapping parameters and emission time constants, development of counter measures for deep trapping, and band gap engineering will enable using garnets as scintillator material without secondary decay time constants, trapping or hysteresis effects.

We consider ceramic scintillator technology as a disruptive technology that will outperform single crystals in terms of the availability of fine-tuned material composition, advanced 3D shapes and pixel structures, and in cost price. Further effort should be put into the development of ceramics array technologies that are needed to enhance detection performance and reduce manufacturing costs. We are aiming at building prototypes of ceramic scintillator arrays, cooperating with various R&D partners in different scientific and engineering disciplines:

1. Ceramic scintillator material development
2. Additive manufacturing, e.g. 3D printing, of structured ceramic materials
3. Encapsulation and packaging of ceramic scintillator arrays
4. Detector assembly, i.e. integration of scintillator arrays with other components, including photosensors, read-out electronics and image data processing
5. X-ray and gamma-ray imaging in different applications domains, such as medical, high-energy physics, security, spectrometry, non-destructive testing, and astronomy

Summary

In the past years Philips has developed ceramic scintillator materials and manufacturing processes for a first generation of pixelated scintillators in medical imaging equipment: gadolinium oxisulfides for CT and garnets for PET.
We consider ceramic scintillator technology as a disruptive technology that will outperform single crystals in terms of the availability of fine-tuned material composition, advanced 3D shapes and pixel structures, and in cost price. Further effort should be put into the development of ceramics array technologies that are needed to enhance detection performance and reduce manufacturing costs. We are aiming at building prototypes

of ceramic scintillator arrays, cooperating with various R&D partners in different scientific and engineering disciplines such as ceramic scintillator material development, additive manufacturing of structured ceramic materials (e.g. 3D printing), encapsulation and packaging of ceramic scintillator arrays, detector assembly (i.e. integration of scintillator arrays with photo-detector / read-out electronics), and X-ray and gamma-ray imaging in different applications domains, such as medical, high-energy physics, security, spectrometry, non-destructive testing, and astronomy.

Authors: Dr WIECZOREK, Herfried (Philips Research / Philips Electronics Nederland BV); JACOBS, Jan (Philips Healthcare); WIMMERS, Onno (Philips Healthcare)

Co-author: Dr RUETTEN, Walter (Philips Research / Philips Electronics Nederland BV)

Presenter: Dr RUETTEN, Walter (Philips Research / Philips Electronics Nederland BV)