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SCAPS, a two-dimensional ion detector for mass spectrometer

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Faraday Cup (FC) and electron multiplier (EM) are of the most popular ion detector for mass spectrometer. FC is used for high-count-rate ion measurements and EM can detect from single ion. However, FC is difficult to detect lower intensities less than kilo-cps, and EM loses ion counts higher than Mega-cps. Thus, FC and EM are used complementary each other, but they both belong to zero-dimensional detector. On the other hand, micro channel plate (MCP) is a popular ion signal amplifier with two-dimensional capability, but additional detection system must be attached to detect the amplified signals. Two-dimensional readout for the MCP signals, however, have not achieve the level of FC and EM systems. A stacked CMOS active pixel sensor (SCAPS) has been developed to detect two-dimensional ion variations for a spatial area using semiconductor technology [1-8]. The SCAPS is an integrated type multi-detector, which is different from EM and FC, and is composed of more than 500×500 pixels (micro-detectors) for imaging of cm-area with a pixel of less than 20 μm in square. The SCAPS can be detected from single ion to 100 kilo-count ions per one pixel. Thus, SCAPS can be accumulated up to several giga-count ions for total pixels, i.e. for total imaging area. The SCAPS has been applied to stigmatic ion optics of secondary ion mass spectrometer, as a detector of isotope microscope [9]. The isotope microscope has capabilities of quantitative isotope images of hundred-micrometer area on a sample with sub-micrometer resolution and permil precision, and of two-dimensional mass spectrum on cm-scale of mass dispersion plane of a sector magnet with ten-micrometer resolution. The performance has been applied to two-dimensional isotope spatial distribution for mainly hydrogen, carbon, nitrogen and oxygen of natural (extra-terrestrial and terrestrial) samples and samples simulated natural processes [e.g. 10-17].
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