

# Rectifier for a THz band radiation sensor, in particular for imaging, and charge collecting system comprising said rectifier.

## Priority Number

102014902271470

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## Patent Type

Patent for invention.

## Ownership

Sapienza Università di Roma 70%,  
Lfoundry Srl 30%.

## Inventors

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## Industrial & Commercial Reference

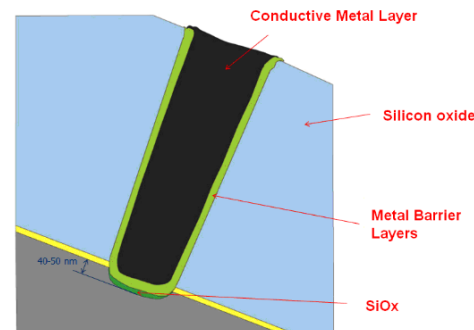
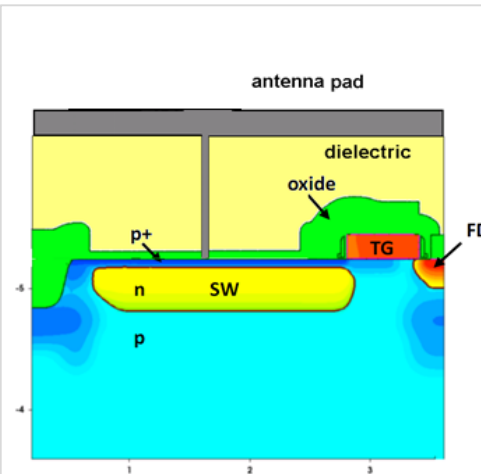
Electronic industry, for the development  
of receivers – transmitters in  
communication systems

## Time to Market

Technology Readiness Level of this  
invention is 3. Tested in integrated  
circuit.

## Availability

Cession, Licensing, Research, Develop-  
ment, Experimentation, Collaboration,  
Start-up and Spin-off.



## Abstract

THz imaging and spectroscopy applications have great potential in time domain spectroscopy, communications, safety control and biomedical imaging.

For this reason, in the last decades a great interest of the research community has been attracted by this region of the electromagnetic spectrum, pushing the THz microwave and optical devices through constant progress in the development and improvement of the detectors in terms of noise equivalent power.

The patent presents a new approach to THz detectors derived from the direct integration of the antenna with a rectifier device obtained by modifying the commercial CMOS active pixel image sensors.

The antenna and the rectifier device form a "rectenna" structure which, exposed to electromagnetic radiation, causes the injection of charge into the storage well (SW).

## KEYWORDS

- ❑ TERAHERTZ
- ❑ DETECTORS
- ❑ IMAGING
- ❑ CMOS

## AREA

- ❑ ELECTRICAL,  
ELECTRONICS &  
ICT  
ENGINEERING

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# Rectifier for a THz band radiation sensor, in particular for imaging, and charge collecting system comprising said rectifier.

## Technical Description

The patented structure has the edge of the metal whisker in contact with the p+ type implanted surface layer, forming a metal–semiconductor junction. The antenna edge thus becomes a part of the electronic device. The semiconductor of the SW completes the structure of the rectifier.

The work function of the metal must be such as to ensure a position of the Fermi level similar to those in highly n doped silicon; for example, titanium (Ti) with a work function of 4.33 eV, a material compatible with CMOS technology, can be used as the terminal portion of the whisker. With the Ti work function, the contact gives rise to a rectifying junction with the “p+ Si” layer; hereafter. The p+ Si layer under the whisker must have a controlled thickness, typically a few tenths of a nano-metre, which can be easily implemented by choosing the dose and energy of the ion implantation.

Due to its reduced thickness, the p+ Si region becomes almost completely depleted of carriers, giving rise to a reduction of the barrier, to a value of 0.3–0.5 eV with respect to the silicon conduction band inside the SW. The doping concentration of the p+ Si region can be modified in order to adjust this barrier height.

## Technologies & Advantages

The proposed device is ideal for the CMOS production process of intelligent systems, which require the ability to control interactions between multiple functionalities and protect sensitive elements from interaction with the environment.

The invention can be applied in systems for monitoring materials in production, for sensing chemical and biological processes, for safety systems and for defense against explosives.

## Applications

THz image detection can be of particular importance from the point of view of safety, both civil and military,

as the research will allow the construction of sensors of high sensitivity and low cost, then usable in explosive detection systems available in large numbers and easily distributed in the environment or transportable by security personnel.

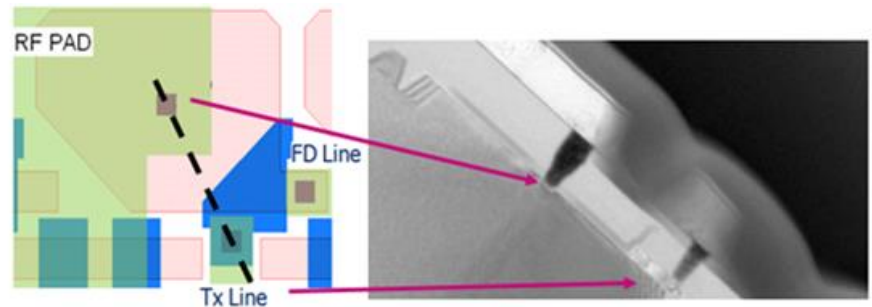
The sensor can be used in cameras for checking images in search of weapons or explosives hidden under clothing, or for postal control, as the radiation at THz is absorbed to a small extent by fabrics and paper.

Since the radiation at the THz is sensitive to the bonds of explosive materials, in particular to the rotational states in the gaseous phase, unlike microwave detection, this method allows the specific identification of the materials.

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Layout and SEM section of the test structure realized with minor changes from a standard configuration of a CMOS photo detector using 0.15µm-technology node



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