

Depth-Selective Positron Nano-Porosimetry System

PALS-1

The PALS-1 is a depth-selective Positron-Annihilation Lifetime Spectroscopy (PALS) system that measures atomic- and nano-scale pores in thin film samples. The depth-selective PALS has widespread use for various materials, such as next-generation very large-scale integration materials, polymer coating films, porous films and so on. The technique, however, has only been available in large facilities with accelerators for positron production. Fuji Imvac Inc. and AIST have developed a compact PALS system that can be used in small laboratories. The PALS-1 system uses an energy variable pulsed positron beam that is implanted into a sample at a selected depth, and the time interval between the incidence of positron and its annihilation with an electron is measured. The pore size can be determined from the annihilation lifetime of the positrons. Our unique techniques of high-efficiency beam production and high-compression beam pulsing enable practical measurements by using a low-activity positron source, and thereby enable the size of the system to be reduced.

Specification and Performance

Dimension : 3m(L) x 0.6m(D) x 1.5m(H)
 Positron source : Na-22 (max. activity 1GBq)
 Observation depth : Surface $\sim \mu\text{m}$ (selective)
 Measurable pore size : atomic-vacancy $\sim 10\text{ nm}$
 Measurement time : < 1h / spectrum

Applications

VLSI materials:

Low-k dielectrics (porous, nonporous), High-k gate dielectrics, Cu barrier films, Electroplated Cu films, SOI, Strained Si, Ion-implanted Si, Resists, ARC, etc

III-V, II-VI semiconductors :

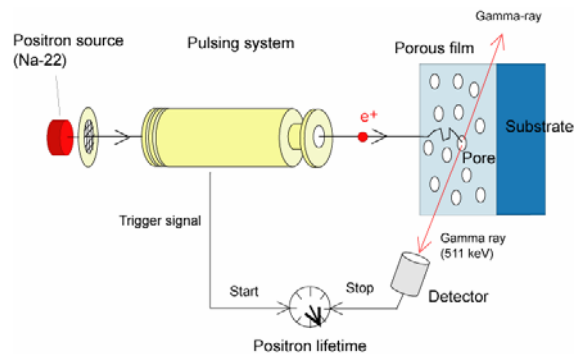
GaN, InN, ZnO, SiC, GaAs, etc

Porous materials, Zeolite, Membranes,

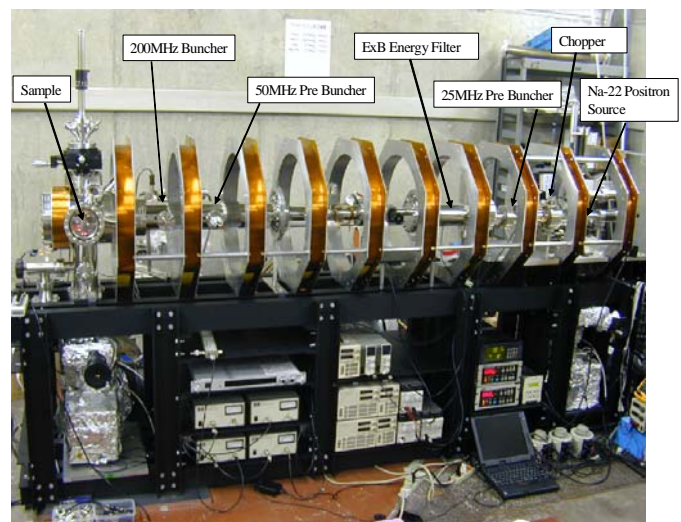
Polymer coating films etc.

Designed and developed by

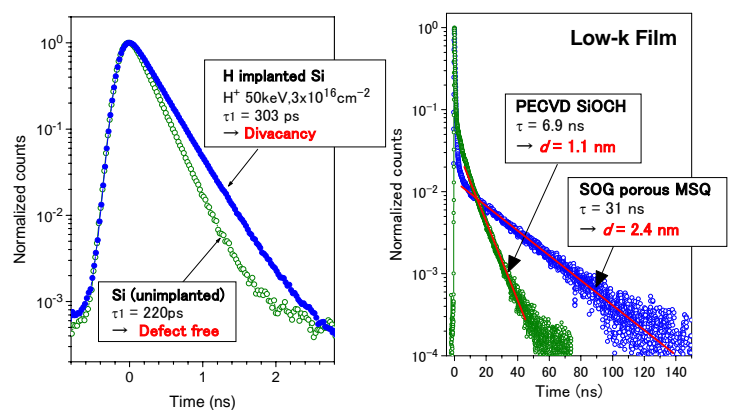
Advanced Defect-Characterization Research Group,
 Research Institute of Instrumentation Frontier,
 National Institute of Advanced Industrial Science and
 Technology (AIST).
 URL: <http://unit.aist.go.jp/rriif/adcg/>



Principle of pulse-beam based PALS system



Overview of PALS-1 system



Atomic vacancies (divacancies) in hydrogen implanted silicon.

Nanometer-sized pores in porous low-k dielectric film.

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