Lift-off photolithography process for electrode preparation of TlBr gamma-ray detectors

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Introduction

SPECT (Single photon emission CT)
SPECT is an attractive nuclear medical device using gamma-rays emitting from drugs accompanying isotopes and is helpful for diagnosis of brain diseases and cardiac diseases. In order to obtain isotopic distributions, many gamma-ray detectors are used for acquiring gamma-ray energy spectra of induced isotopes in patient body. Isotopes for SPECT:
- Epilepsy, Brain infarction and Dementia (123I)
- Brain cancer (131I, 137Cs)

Advantage of TlBr for SPECT
Due to high atomic number and high density, TlBr has higher absorption than CdZnTe or NaI for high energy gamma-rays from the isotopes used in SPECT.

Present electrode formation for TlBr detectors
Vacuum evaporation with a metal mask
- Unsuitable method for mass production in factory!
- Forming fine electrode structure by using metal mask is difficult.

Challenge
Photoresist technique has been used for mask construction on semiconductor wafer in typical production process. Forming masks on TlBr crystals by a lift-off photoresist technique was carried out for the first time challenge.

Photoresist procedure

Pre-coating
- TlBr crystals (Thickness: ~0.5 mm)
- IMSD
- Spin coater: 500 rpm 3s → 1,000 rpm 30s
- Baking: 100°C, 2min.

Resist coat
- Lift-off photoresist: NR0730(Nagase Chemetex Corporation)
- Spin coater: 500 rpm 3s → 3,000 rpm 30s

Pre-baking
- 100°C, 5min.
- Lift-off resist
- TlBr crystal thickness: ~0.5 mm

UV irradiation
- 180s
- Back side
- Back side

Development
- Developer: CD-26DEVELOPER, 30 s.
- Rinse: Distilled water

Au evaporation
- Au

Resist remove
- NMP, 70°C
- NMP

Evaluations

I-V characteristics and resistivity
TlBr detectors fabricated by the lift-off photoresist procedure showed ohmic characteristics same as a TlBr detector fabricated by the previous standard process using metal mask. Resistivity of TlBr detectors made by both procedure calculated from the curves were equivalent. These results mean that the photoresist on the TlBr crystals completely removed and optimum electric contact were formed between Au electrodes and TlBr crystal surface.

Charge transport properties (μ products)
Fig. 9 shows μ products for electrons and holes in TlBr detectors evaluated by a conventional system and Hecht equation. The results shows the photoresist procedure cause no degradation to charge transport in TlBr crystals.

Conclusions
The results mean that the detector fabrication procedure by the lift-off photoresist in this study is promising procedure for electrode formation on TlBr detectors used for X-ray and gamma-ray spectroscopy with fine pitch electrodes.

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