Pellet-Based BiSI/a-C Detectors: Fabrication and Electrical Response

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INTRODUCTION

Ionizing radiation is imperceptible to human senses → detection requires an intermediary material.

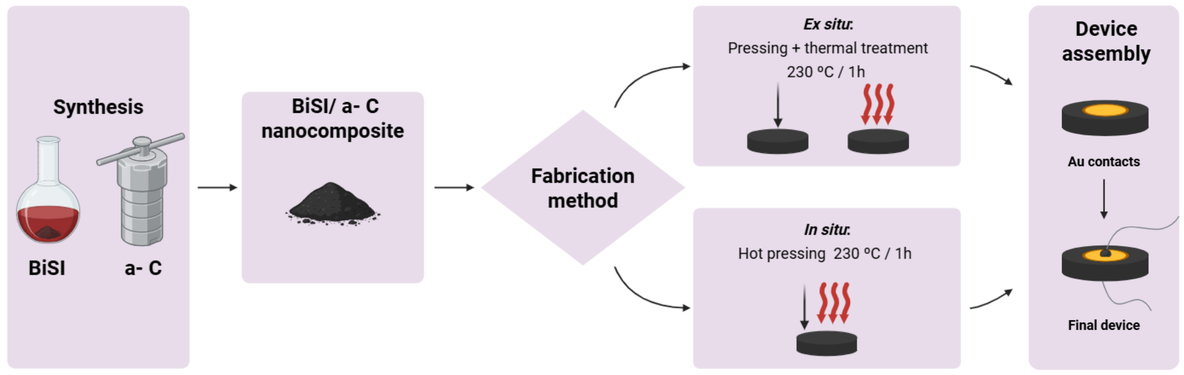
Semiconductor detectors convert radiation directly into electrical current → higher sensitivity, faster response, no indirect conversion steps needed.

Single-crystal growth for radiation detectors is challenging → this work focuses on fabricating detectors from **pressed pellets of a BiSI/amorphous carbon (a-C) nanocomposite** as an accessible alternative.

BiSI is an ideal candidate: suitable band gap (**1.6 eV**), high X-ray absorption coefficient, low toxicity.

Goal: optimize the fabrication process by investigating different **BiSI:a-C ratios (90:10 / 75:25) and thermal treatments** (*ex situ* / *in situ*), correlating pellet morphology with electrical performance to produce functional prototypes for characterization and application.

MATERIALS & METHODS



RESULTS

Starting Materials

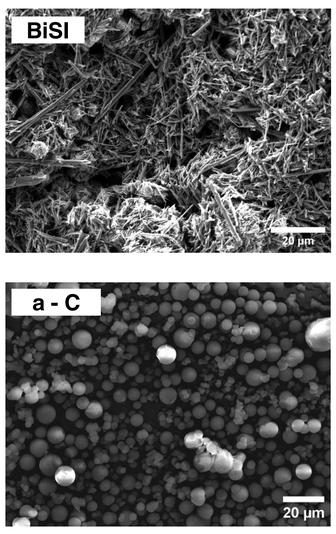
Starting materials were characterized by powder X-ray diffraction (XRD), to confirm compound identity, and scanning electron microscopy (SEM), to study morphology.

BiSI

- Nanorods, 337 nm average width. Obtained by solution synthesis from bismuth sulfide (Bi_2S_3) and iodine (I_2).

a-C

- Rounded amorphous particles, 5.7 µm average diameter. Obtained by solvothermal synthesis from ethylene glycol and iodine.



Pellet Fabrication & Characterization

Sample	BiSI (%)	a-C (%)	TT
BC_9010_ex	90	10	*Ex situ*
BC_9010_in	90	10	*In situ*
BC_7525_ex	75	25	*Ex situ*
BC_7525_in	75	25	*In situ*

Mixtures were prepared in known BiSI:a-C ratios. Pellets (13 mm diameter) were fabricated by pressing the nanocomposite and characterized by SEM and XRD.

Sample naming: BC_XXYY_TT — BC: BiSI/a-C mixture · XX: % BiSI · YY: % a-C · TT: thermal treatment

Ex situ

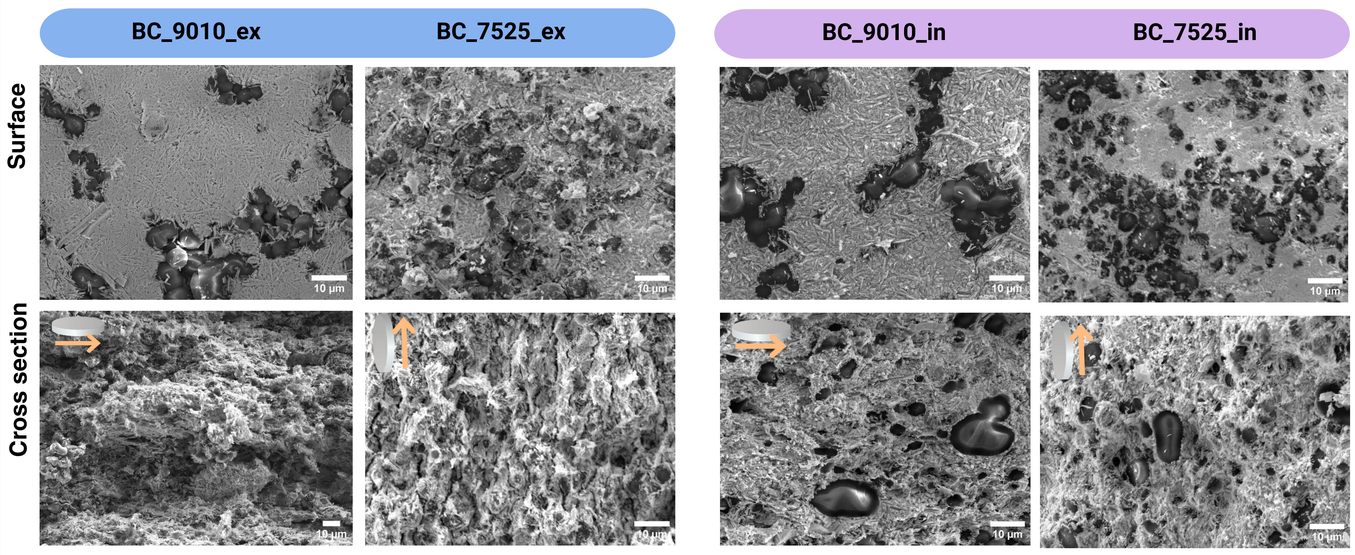
a-C particles coalesce on the pellet surface, while preserving their morphology in the interior.

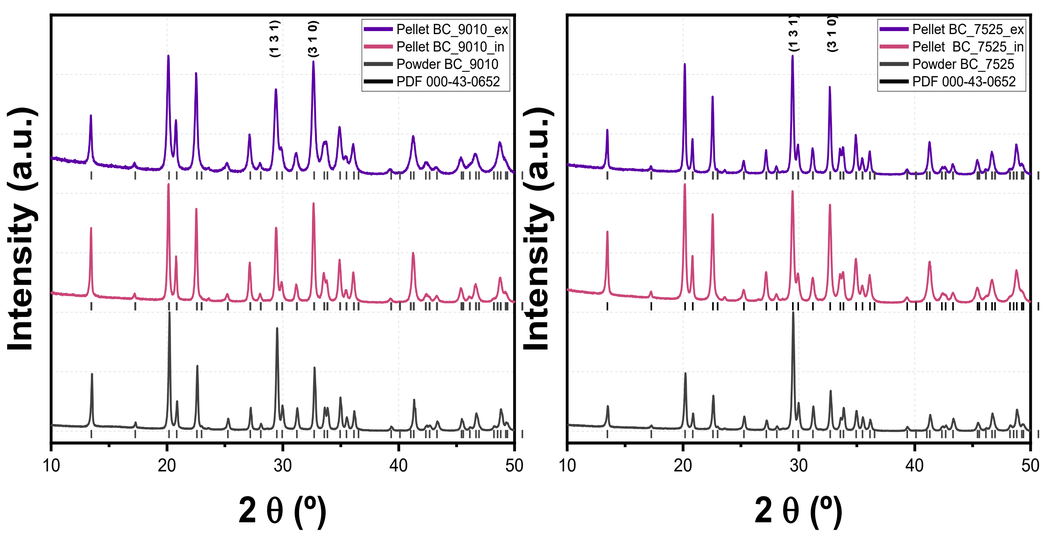
BiSI nanorods maintain their initial morphology

In situ

a-C particles coalesce both on the surface and in the interior of the pellet

BiSI nanorods maintain their initial morphology





XRD confirmed that compound identity is preserved after the different thermal treatments.

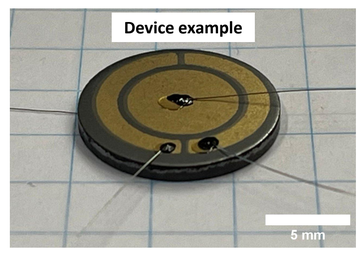
Pellets show relative peak intensity changes vs. starting powder → attributed to preferential nanorod orientation, disrupted by a-C acting as a physical obstacle.

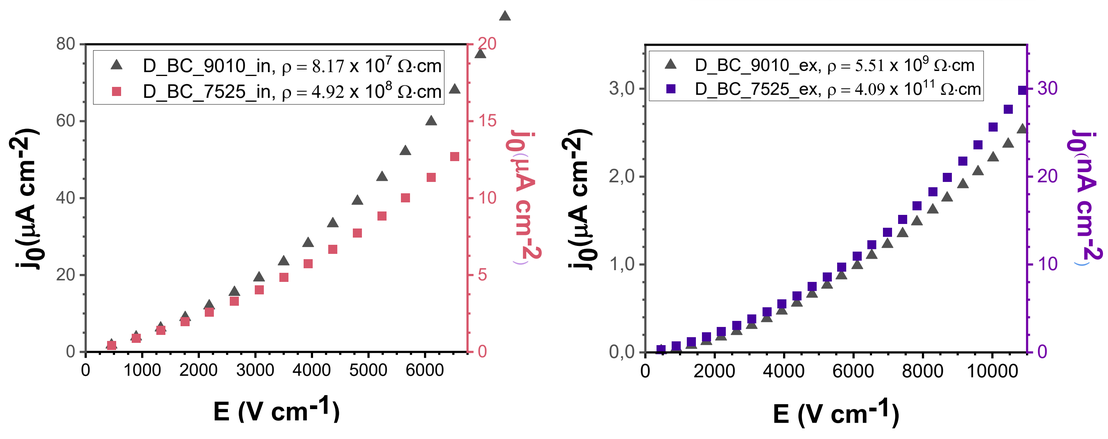
Device Performance

Electrical characterization performed via I–V curves.

Dark current

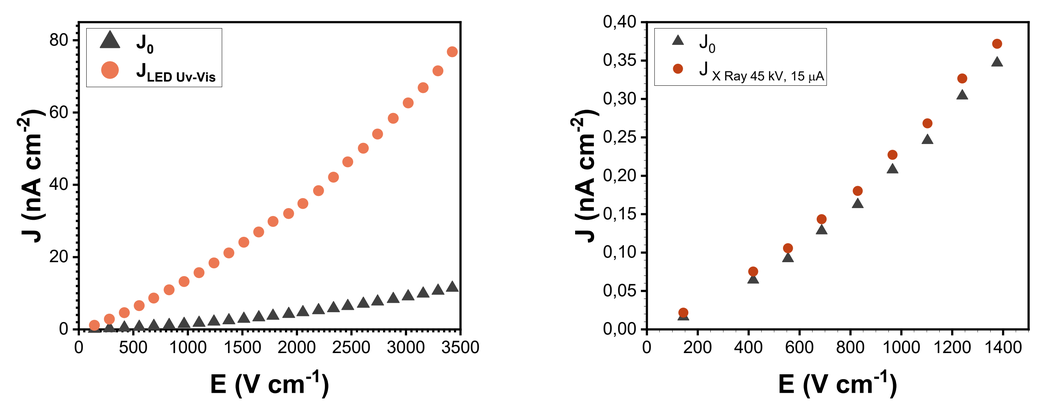
•BC_7525_ex shows the highest resistivity → best performance as a radiation detector.





Visible light and X-ray response

•Preliminary tests under UV-Vis LED and X-ray irradiation showed that BC_7525_ex exhibited the strongest photoresponse under both excitation sources.



CONCLUSIONS AND FUTURE WORK

- BiSI phase preserved after pressing and thermal treatment in all pellets.
- a-C content affects nanorod orientation: preferential alignment in **90:10**, not in **75:25**.
- No nanorod sintering at 230 °C; a-C coalescence more pronounced ***in situ***.
- ***Ex situ*** pellets show higher resistivity than ***in situ*** (up to 3 orders of magnitude).
- **BC_7525_ex** shows the best overall performance: lowest dark current, strongest response to visible light and X-rays.

Future Work

- Ongoing electrical characterization and interpretation of results, aiming to identify **key characteristic parameters** for a complete device analysis.

Acknowledgements

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References

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