



Microplastic Release from E-Beam Sterilized Polymeric Materials Used in Contact with Aqueous Fluids

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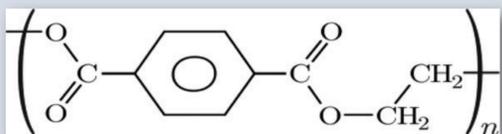
ABSTRACT ID 186

AccelApp²⁴

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Introduction

- PET in Packaging and Medical Industries.
- PET is a Thermoplastic polyester synthesized by polycondensation of ethylene glycol and dimethyl terephthalate.
- Crystallinity, Resistance to water and Chemicals, Durability of the end point Thermal Stability, Recyclability and low cost, extensively used for liquid packaging and storing.



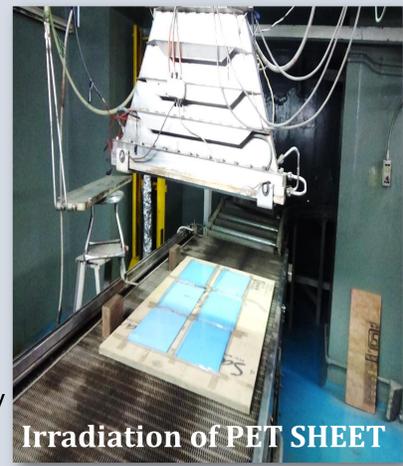
Chemical Formula of PET(C₁₀H₈O₄)_n



Electron Beam Facility at BRIT Mumbai

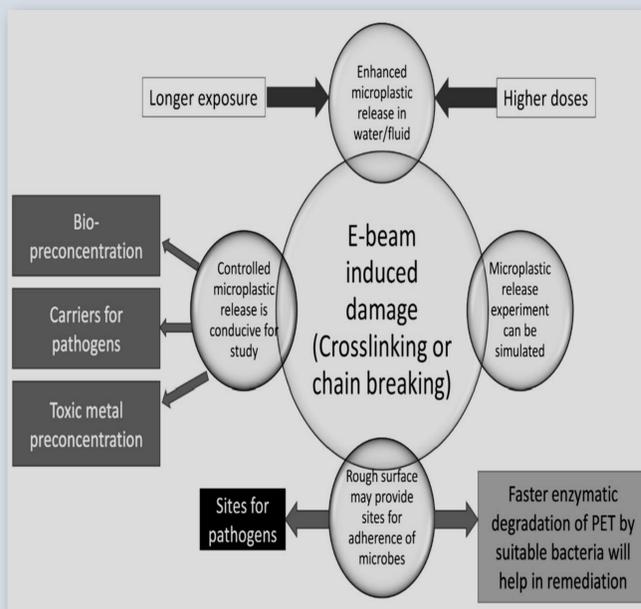
Specifications of Electron Beam Facility

- E-beam Energy : 3.5 MeV
- E-beam Current (Pulse Current) 250mA
- E-Beam Average Current: 1mA
- Pulse Repetition Rate: 10 Pulses/ Second, 10Hz,
- Conveyer Speed: 3 Cm/ Second
- Dose Per Pass: 5kGy Per Pass
- Dose Range: 5 KGy, 25 kGy, 50 kGy, 75 kGy, 100 kGy
- Size of Sample: A4 Size Sheet



Irradiation of PET SHEET

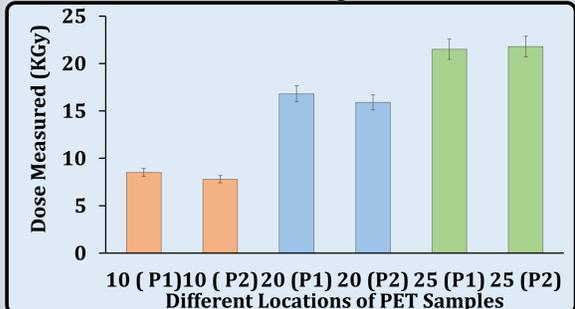
Overview of Micro plastic Release



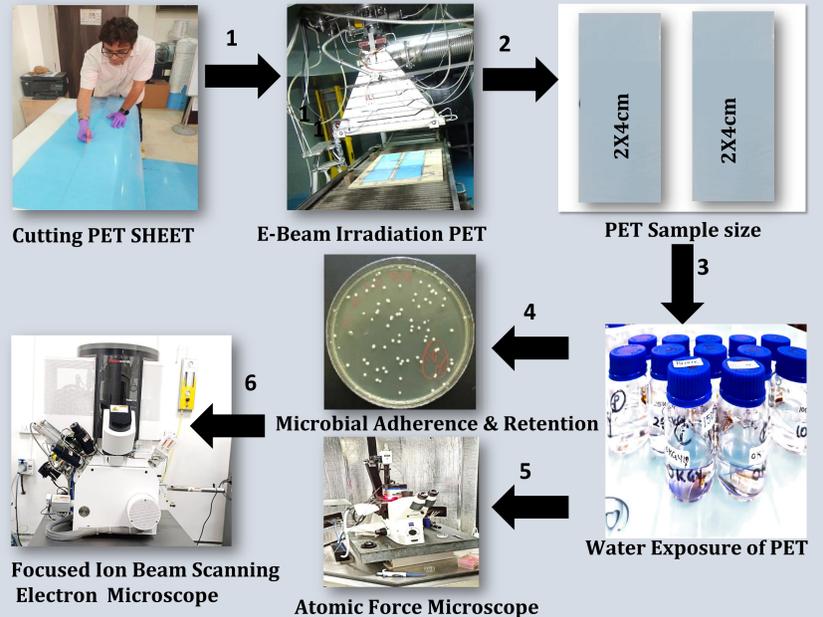
E-Beam Dose Monitoring of PET Samples

Dose Expected (KGy)	Dose Measured (KGy)
10 (P1)	8.5 ± 4
10 (P2)	7.8 ± 4
20 (P1)	16.8 ± 4
20 (P2)	15.9 ± 4
25 (P1)	21.5 ± 4
25 (P2)	21.8 ± 4

Variation of Monitored Dose using Radiochromic B3 films

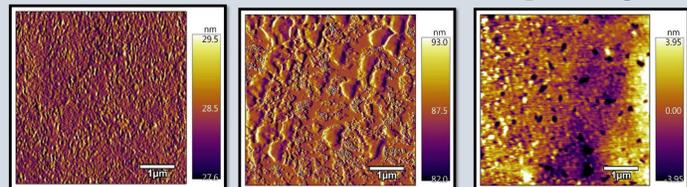


Experimental



Results

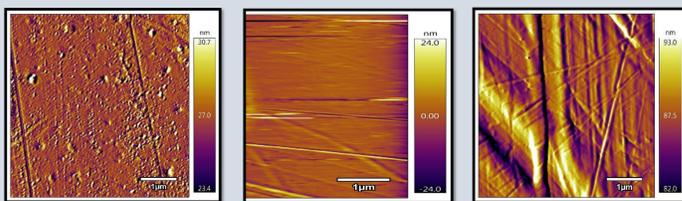
Irradiated PET Atomic Force Microscopic Image



0 KGy 25KGy 50 KGy

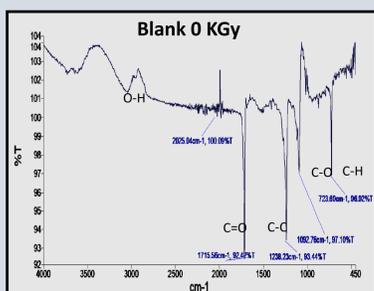
- Physical Changes and Morphology become more rough at 25 KGy. Increasing dose to 50 KGy, crosslinking and PET chain scissions resulted to shrinking of polymer matrix and formation of pores.
- After immersion of PET samples in water, the surfaces were changed significantly suggesting loss of materials in the form of micro plastics in equilibrating water.

Irradiated & Water Exposed PET AFM Image Profile

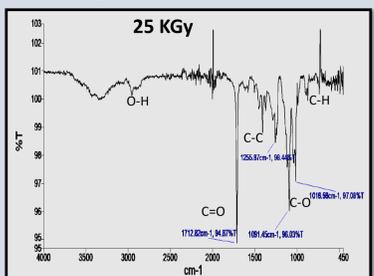


0 KGy 25 KGy 50KGy

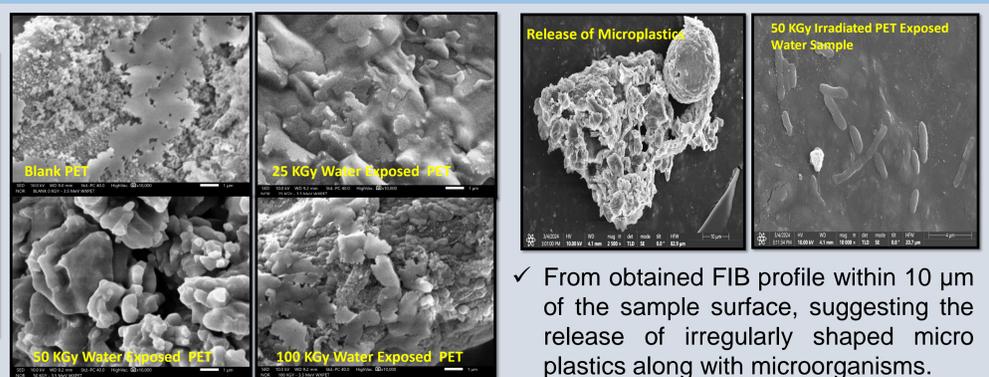
ATR-FTIR Spectroscopy



- PET chain breaking upon irradiation.
- Breaking of Ester Bond
- Peak splitting in the C-O bond
- Changes in the O-H bond



FIBSEM Profile of Water Sample in Contact with PET



- From obtained FIB profile within 10 μm of the sample surface, suggesting the release of irregularly shaped micro plastics along with microorganisms.
- FIBSEM Images corroborated observations made in AFM studies,
- To observe the changes in the morphology with electron beam dose depending upon extent of crosslinking and chain breakings.

Microbial Adherence Study : PET Ex. Water samples

Sr. No.	Water Samples	Bacterial Retention (%) of E. coli ATCC 6538	Percent increase of E. coli ATCC 6538
1	10 KGY-3.5 MeV PET XW	100	Not significant
2	20 KGY-3.5 MeV PET XW	100	
3	25 KGY-3.5 MeV PET XW	100	21.24%
4	50 KGY-3.5 MeV PET XW	100	414.29 %
5	100 KGY-3.5 MeV PET XW	100	1043 %

Microbial growth enhanced due to higher release of microplastic with higher dose of E-beam.



Conclusion

- Higher doses of E-Beam: Enhanced release of micro plastics & of microbial growth in water
- Increased doses cause more extensive fragmentation of PET, resulting in a greater surface area available for microbial attachment and colonization.

Acknowledgement

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- Sophisticated Analytical Instrumental Facilities (SAIF) IIT Bombay.
- Bombay Textile Research Association (BTRA) Mumbai India.

References

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