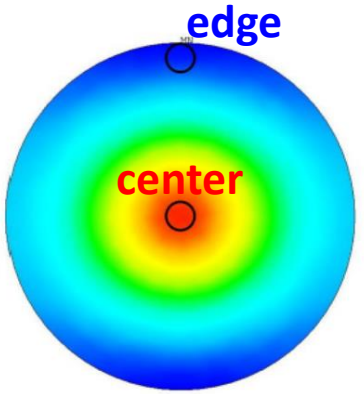
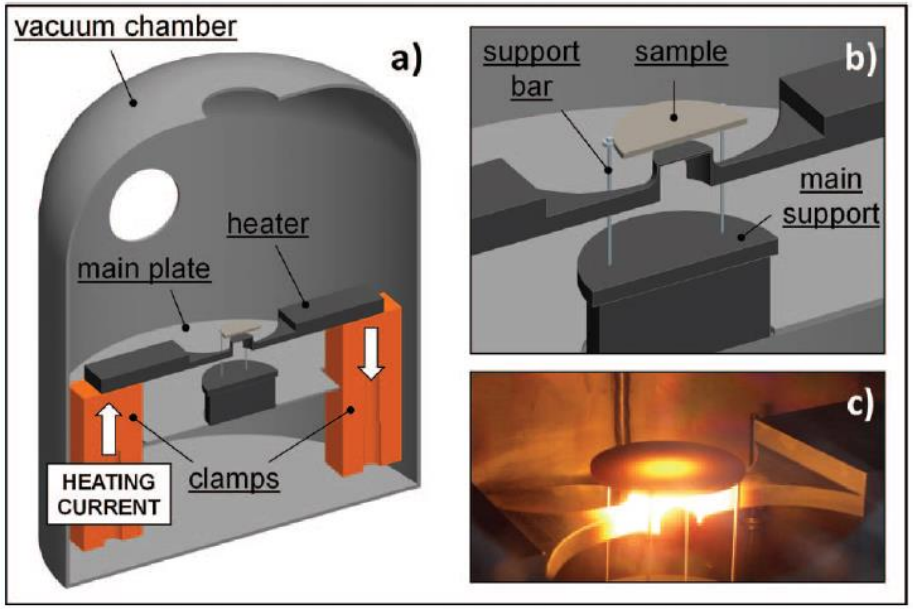
Thermo-cycled graphite target

Provided by S. Corradetti (LNL)

- EDM-3 POCO Graphite: polycrystalline graphite
- Thickness: 1 mm
- Radius: 2 cm
- Machine cut @LNL in 2017 from graphite cylinders POCO EDM 3
- Thermo cycled ~ 5 times in vacuum: T_{max} ~ 1500 °C **(center)** T_{min} ~ 1100 °C **(edge)**
- Thermal conductivity measured (optimal function well reproduced)

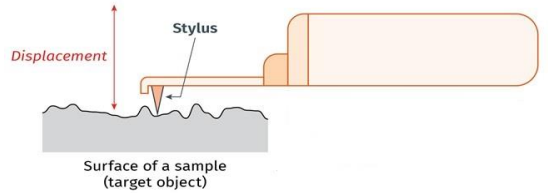




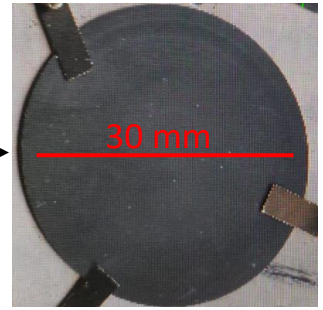
Materials (2021), **14**, 2689.
https://doi.org/10.3390/ma14102689

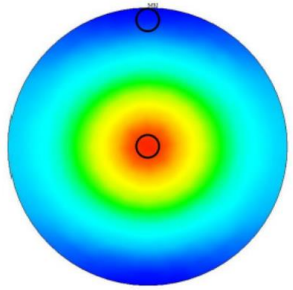
Morphological characterization

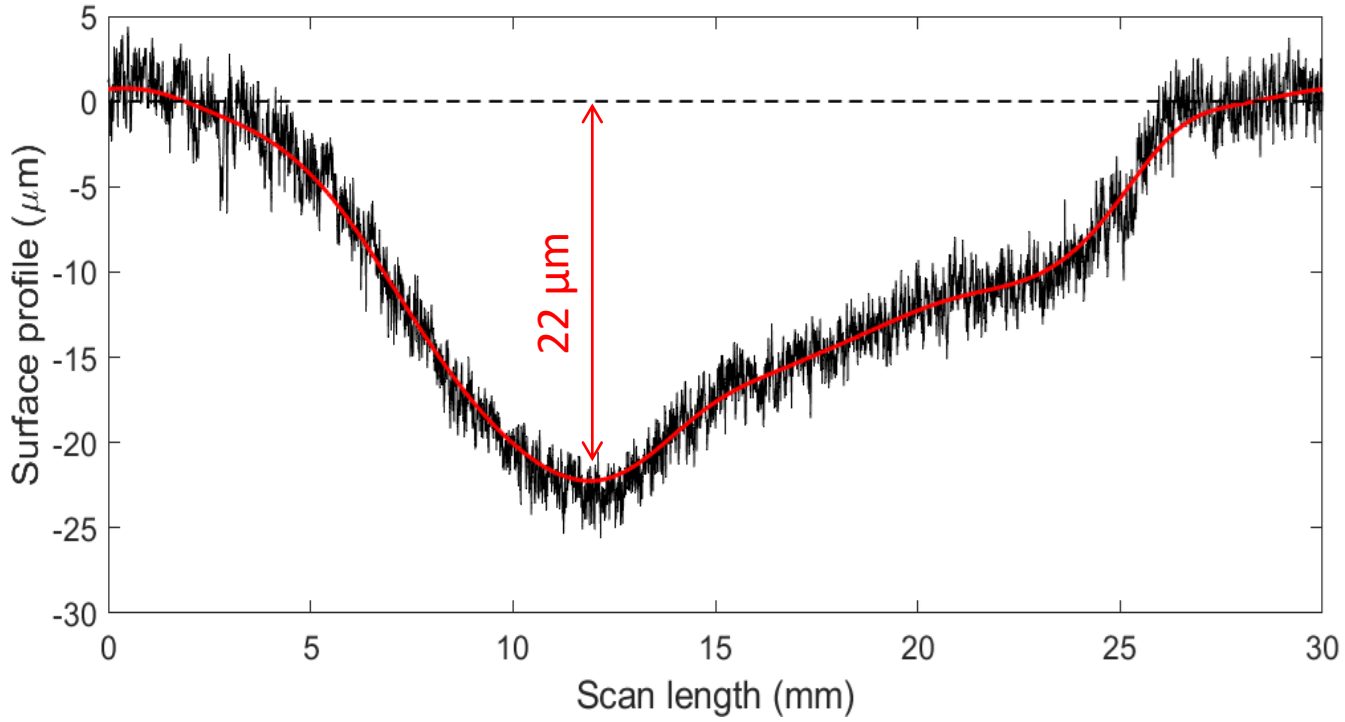
Surface profiling @SurfaceLabRoma3, INFN Roma Tre



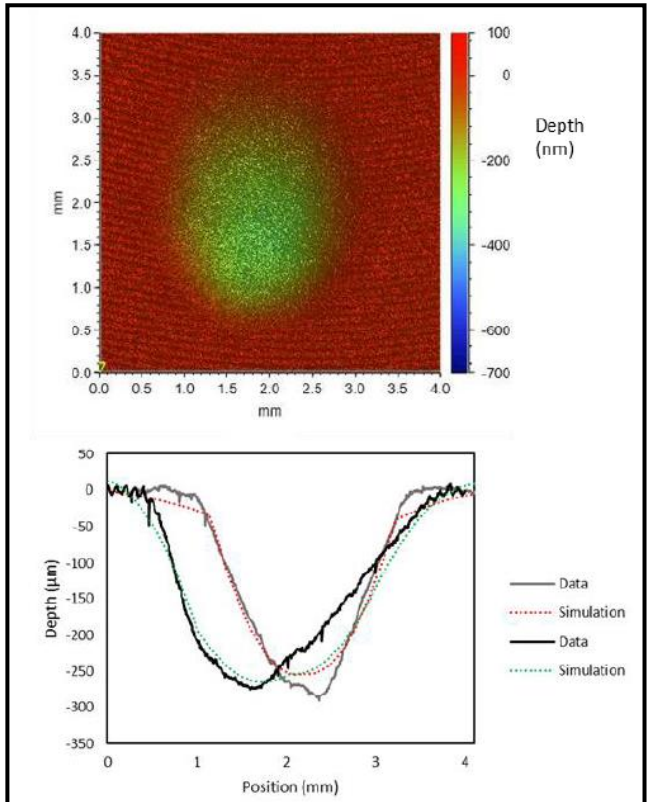
Profile







Possible material removal mechanism due to thermo-cycled treatment at 1500 °C (target **center**)



Similar to (?)

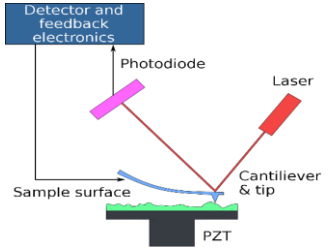
Journal of Applied Physics (2021) **129**, 043102

https://doi.org/10.1063/5.0033530

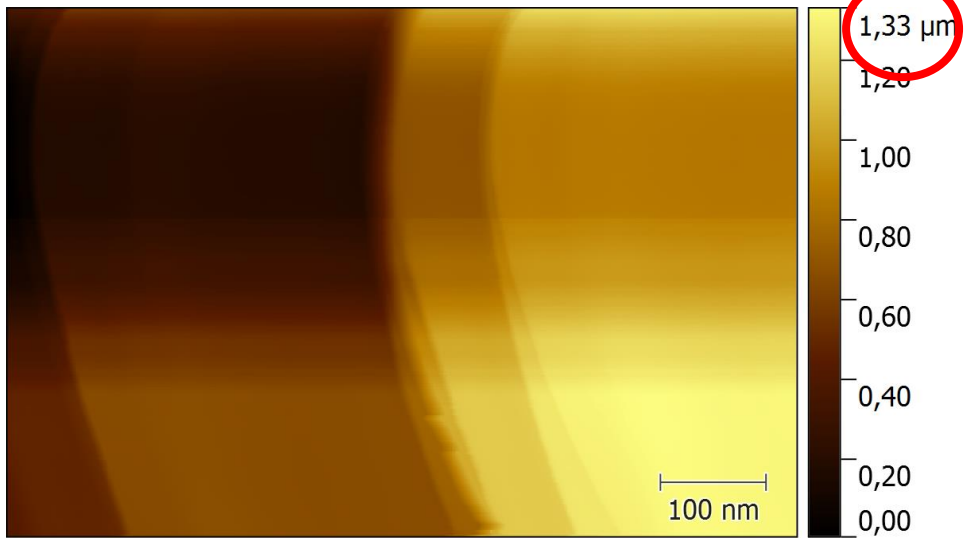
Morphological characterization

Surface mapping with Atomic Force Microscopy (AFM)

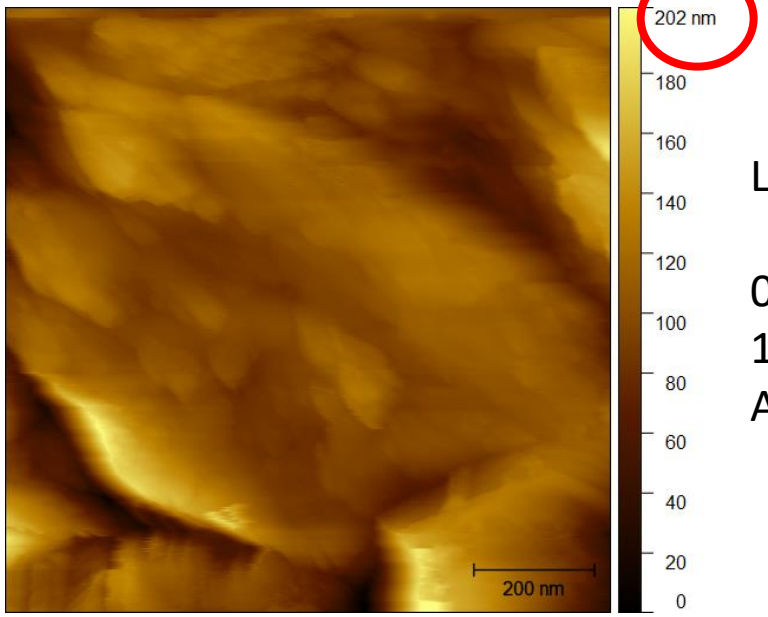
@SoLINano Lab, Politecnico Milano, Physics Department



Untreated target



Thermo-cycled target



Local morphology:

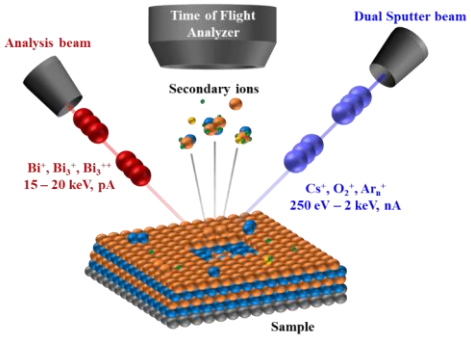
0.5 µm x 0.8 µm (**untreated**)
1 µm x 1 µm (**treated**)
AFM surface images

Strong local morphological changes at sub-micrometric scale induced by the thermal treatment

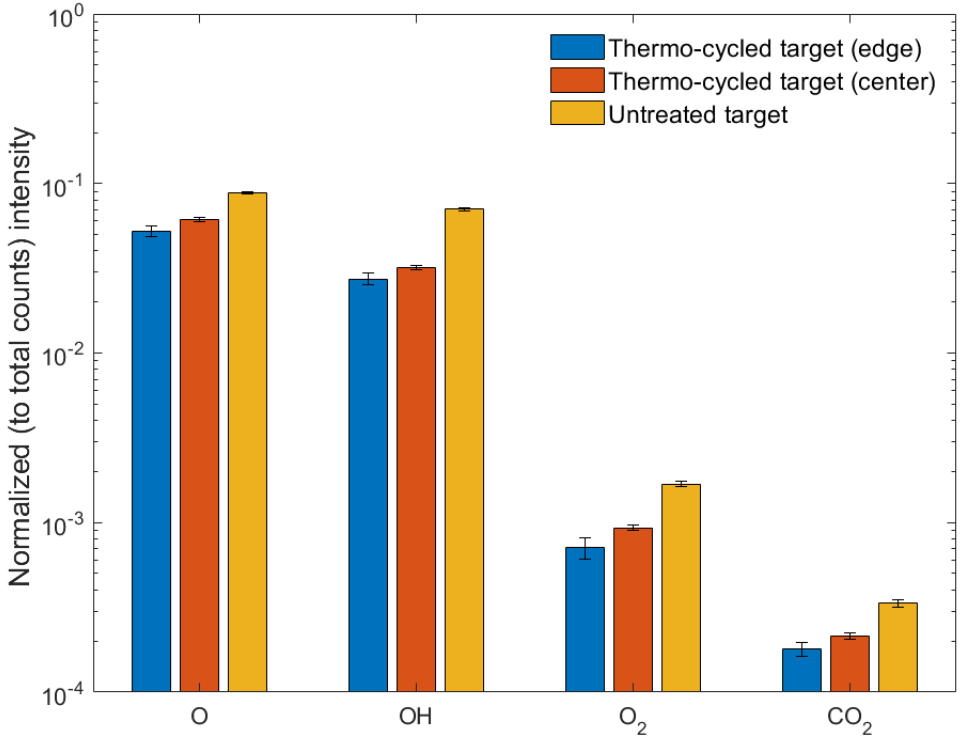
Surface/bulk chemical characterization

Low-energy ion beam analysis

@SurfaceLabRoma3, INFN Roma Tre



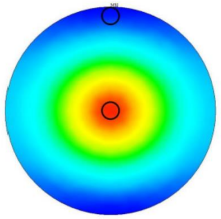
Oxygen-based peaks



Difference in oxygen content treated/untreated targets

↓

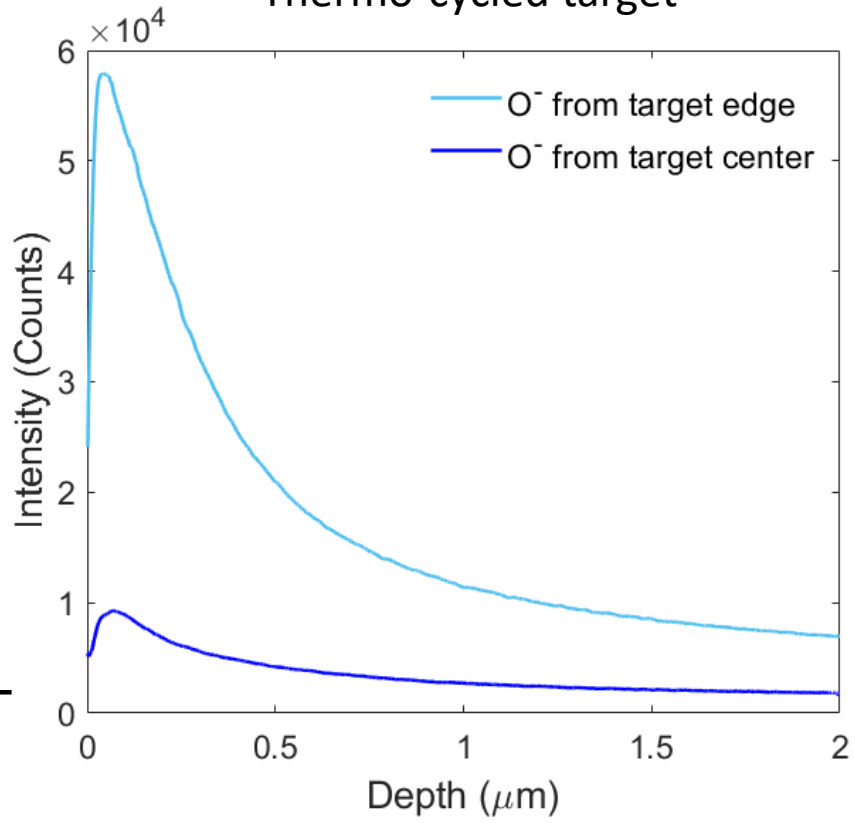
Thermal-induced chemical modification



Possible diffusion effects due to thermal treatment (?)

←

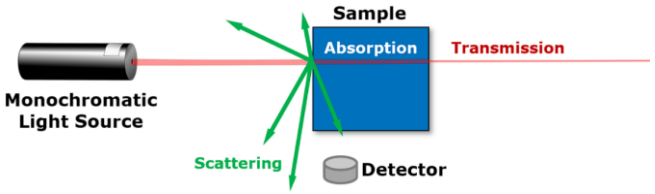
Thermo-cycled target



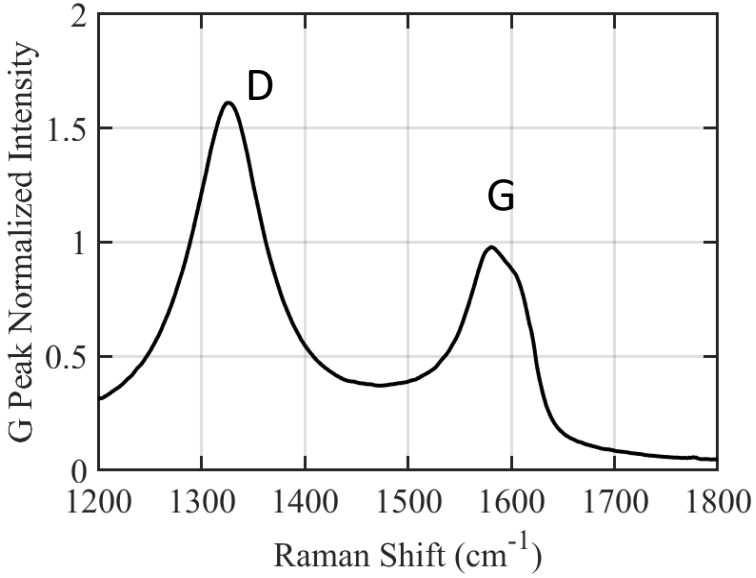
Structural characterization

Raman spectroscopy

@ SoLINano Lab, Politecnico Milano, Physics Department

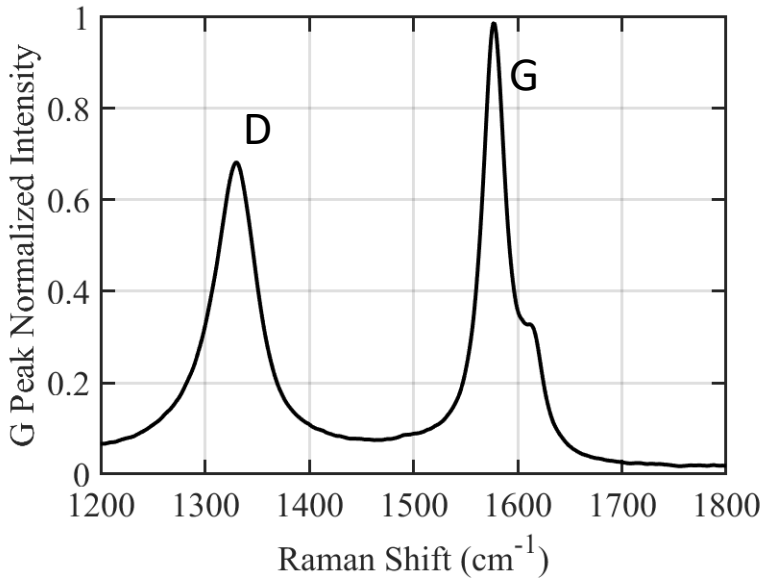


Untreated target



	Mean	Error
D Peak	1.6	0.1
Shoulder	0.7	0.1

Thermo-cycled target



	Mean	Error
D Peak	0.7	0.2
Shoulder	0.33	0.07

D/G intensity peak ratio decrease

↓

Increased structural order

Summary

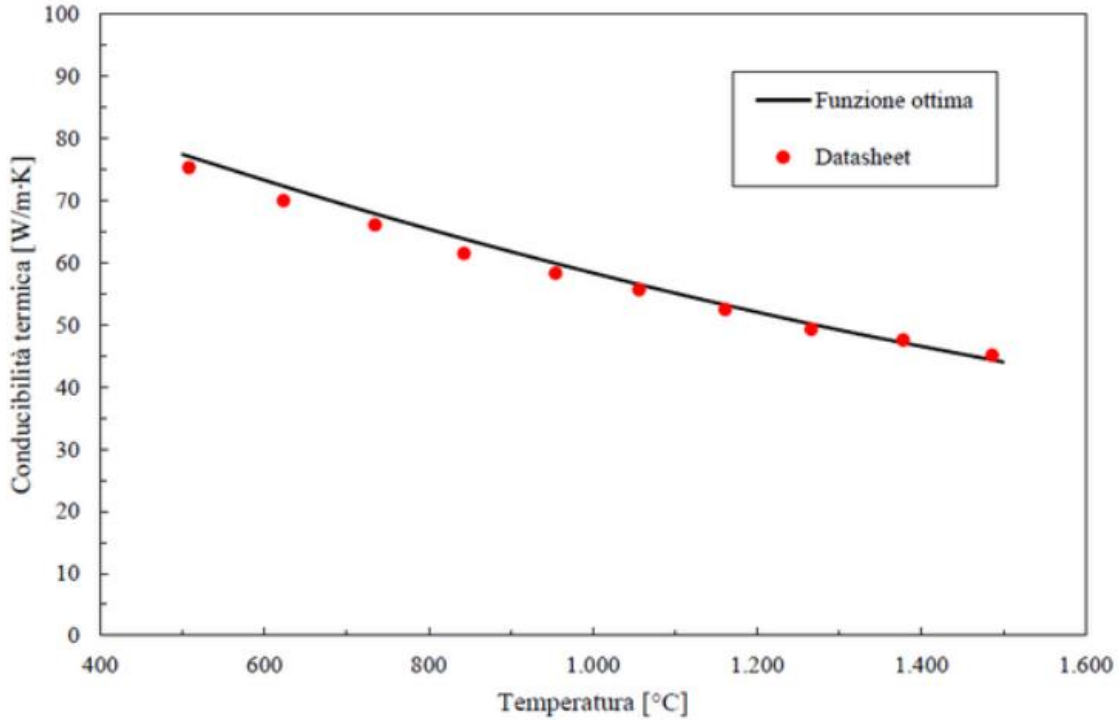
- **Possible material removal effect due to thermal treatments**:
  - Our experimental results can be compared to simulated data from current models.
  - Properties of interest (e.g., thermal gradient, structural changes, temperature increase) can be derived by a numerical model to be developed for the analysis of our experimental results.

- **The cycled thermic treatment alters the chemical and structural properties of the graphitic targets**:
  - Such thermal-induced effects (e.g., oxygen-based species reduction, increase in crystallinity, formation of different carbon species) must be taken into account in the fine tuning of predictive models about the target response to thermic stress.

- **This experimental approach can be applied also for characterizing beam-radiated targets**.

Backup

Provided by S. Corradetti (LNL)



Journal of Applied Physics **129**, 043102 (2021)
https://doi.org/10.1063/5.0033530