Development of TiO_2 wide bandgap semiconductor detectors for intense pulsed proton beam monitoring at J-PARC

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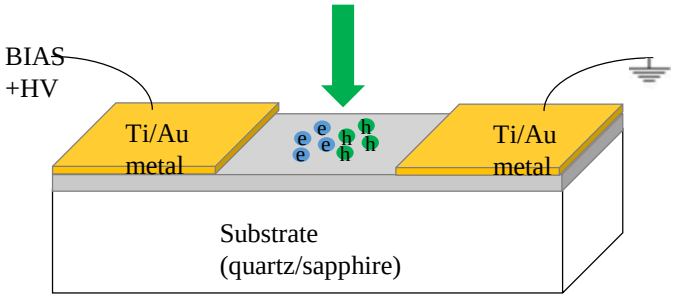
New method for fabricating thin TiO_2 detectors

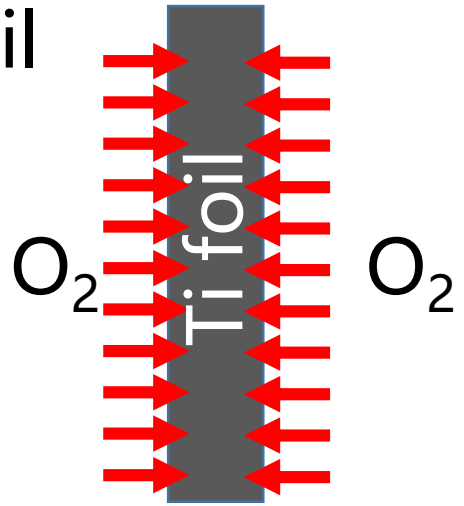
Earlier



Thin (0.3um) TiO_2 layer on 1.5mm Quartz support

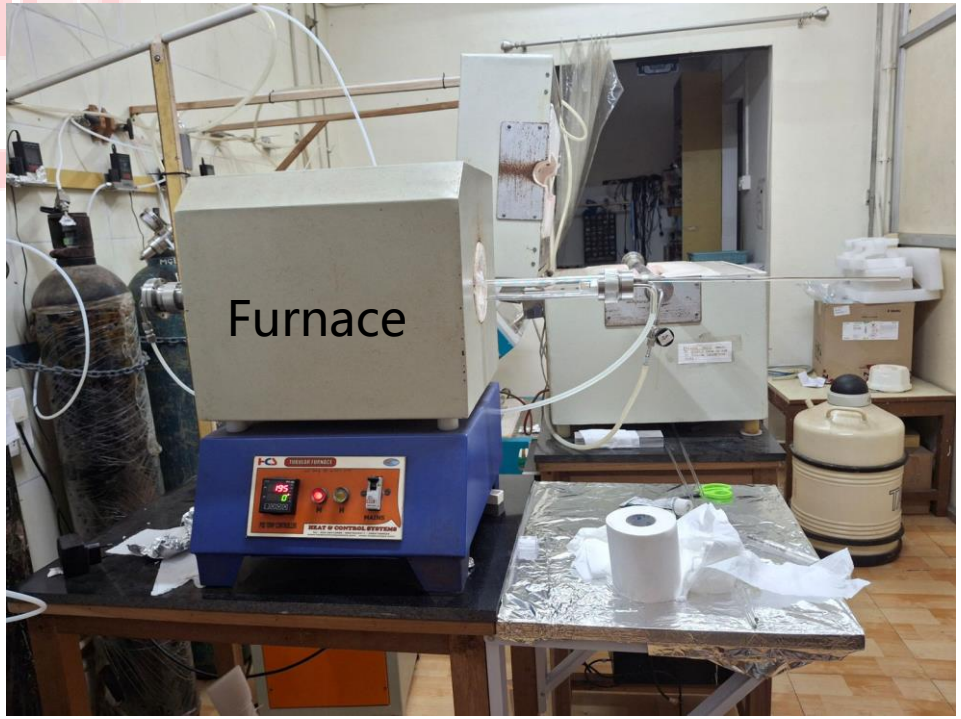
Now

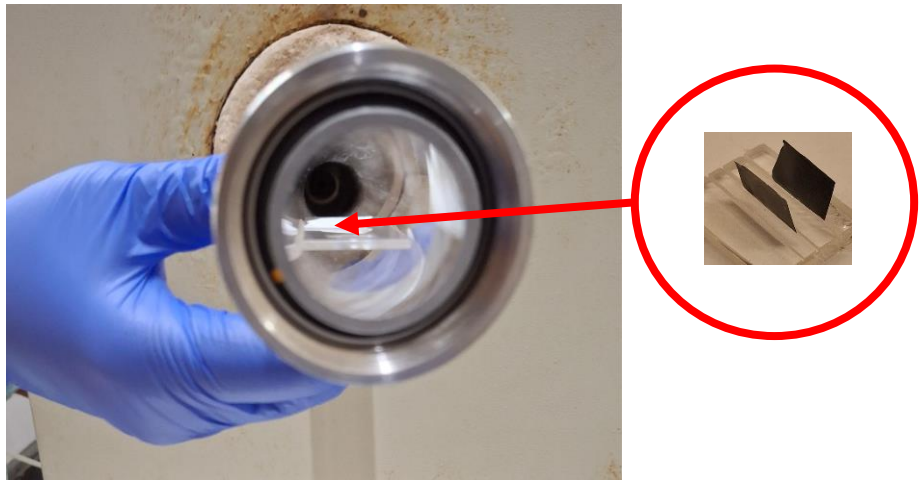
Direct oxidation of Ti foil



In 800C, TiO_2 crystal is formed on the surface

Current state of the art(craft) - fabrication

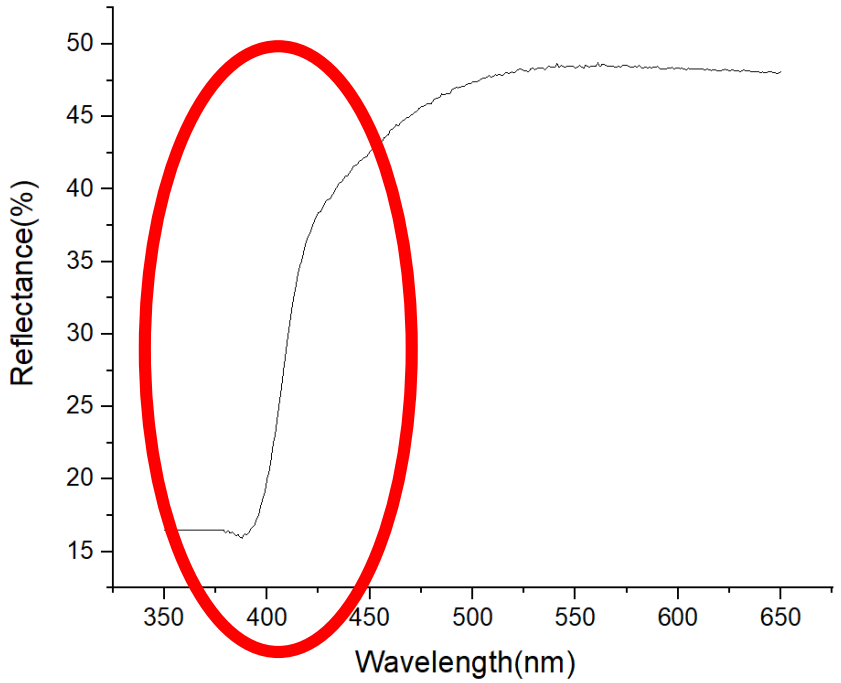




Temperature profile for annealing:
27C to 800C in 2 hours
Stable at 800C for 10 minutes
800C to 27C cooling period

Current state of the art – characterization

UV-vis spectrophotometry gives bandgap



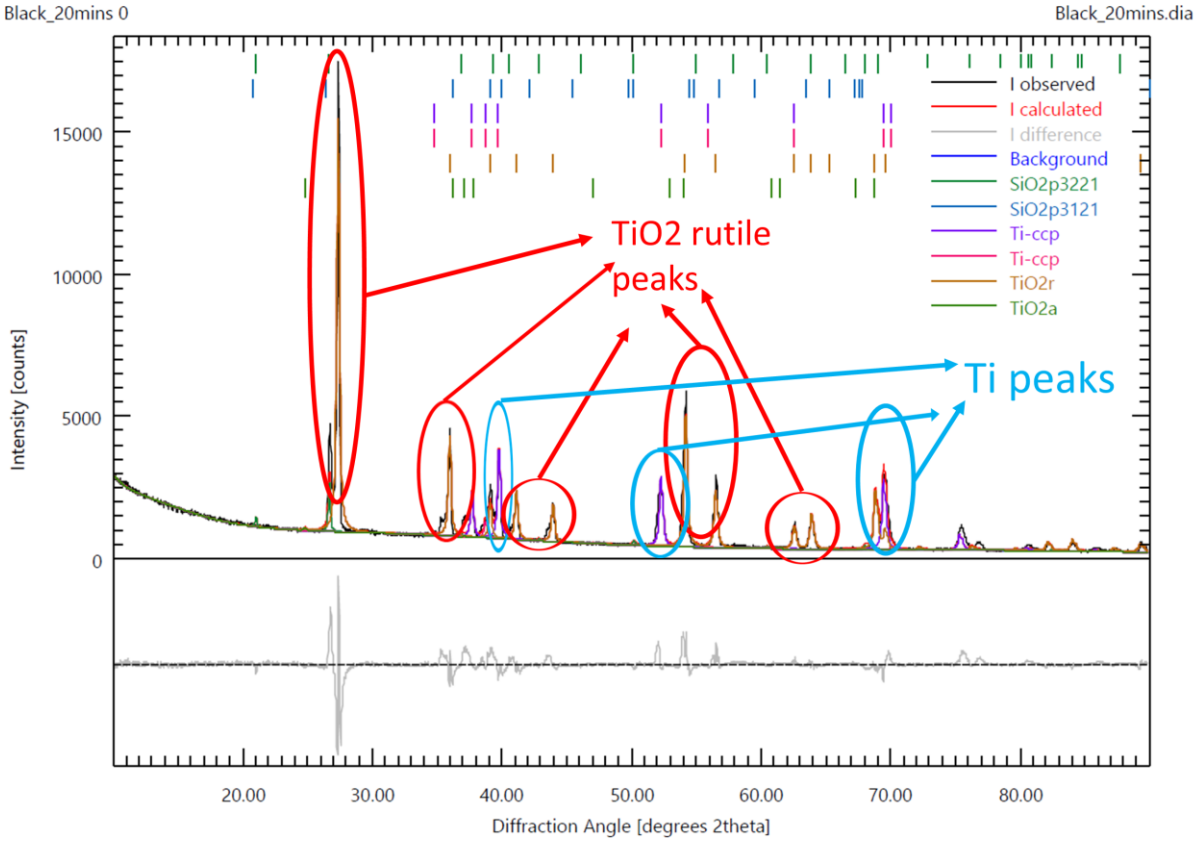
$\lambda = 400nm$

$E_g = hc/\lambda$

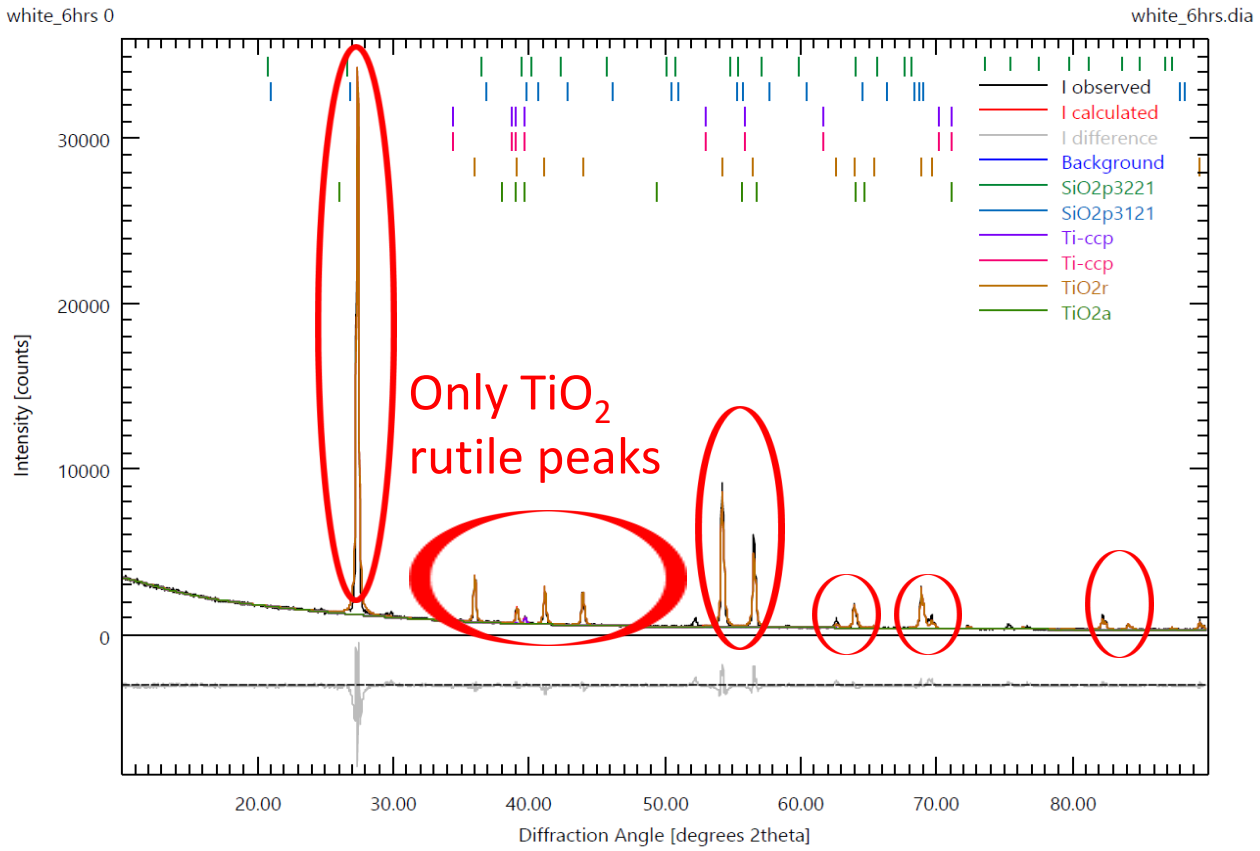
$= 1240(eV\text{-}nm)/\lambda(nm) \sim 2.6\ eV$ (close to published value)

Ref. Landmann, M., Rauls, E., & Schmidt, W. G. (**2012**). The electronic structure and optical response of rutile, anatase and brookite TiO_2. *Journal of Physics: Condensed Matter, 24*(19), 195503.

XRD shows stable Rutile-phase



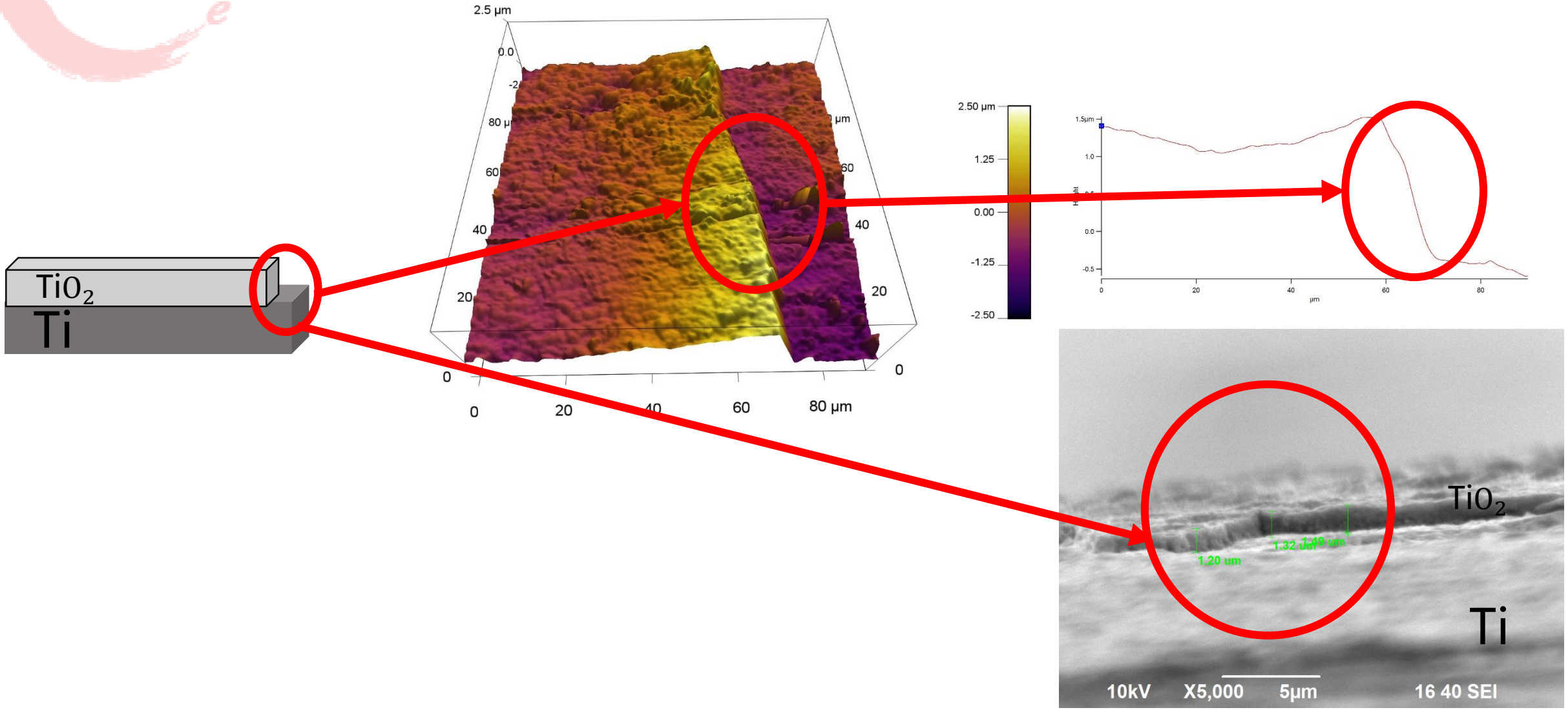
Sample MT3.1 which was oxidized for 20 minutes
Shows combination of Ti and TiO_2 peaks



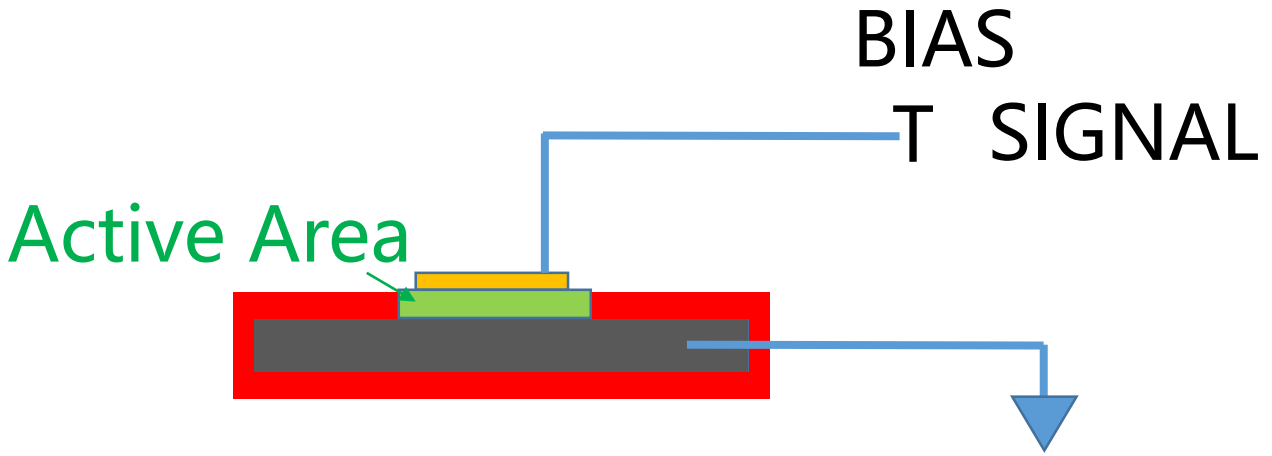
Sample MT3.2 which was oxidized for 6 hours in 50SCCM O_2 environment for 6 hours
Shows exclusively TiO_2 peaks.

Current state of the art – characterization

AFM & SEM – surface quality



Key milestone ahead



Problem:

In our fabrication process, all exposed surface of Ti gets oxidized to TiO

We need to make electrical contact to the core Ti, to set it at ground potential to make a detector

with low dark current

high signal