

PAUL SCHERRER INSTITUT



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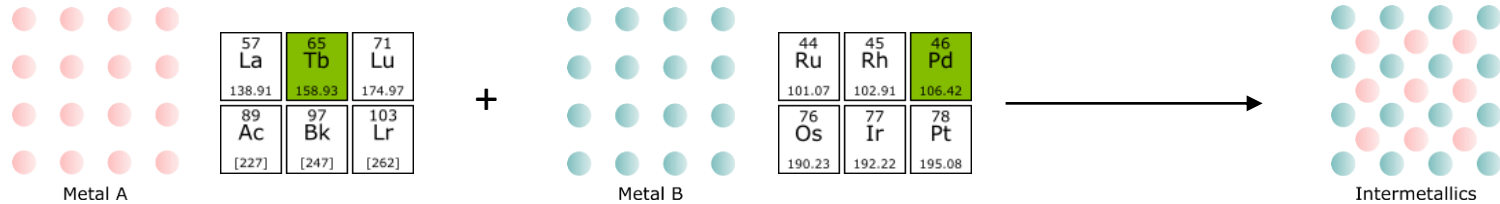


Noemi Cerboni :: PhD Student :: Paul Scherrer Institut

Analysis of Thin Tb/Pd Intermetallic Targets Prepared by the Coupled Reduction Reaction

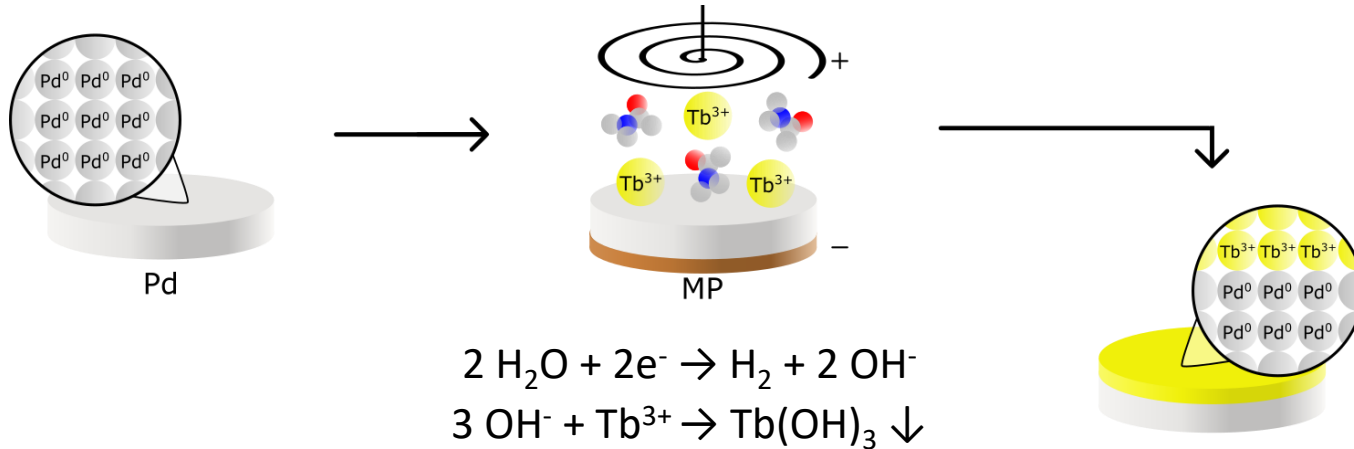
INTDS 2022, 26.09.2022

- **Intermetallics:** 2 or more metals with defined stoichiometry and ordered crystal structure, different than constitual elemental components, covalent/ionic/metallic bonding

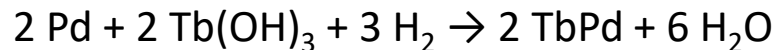
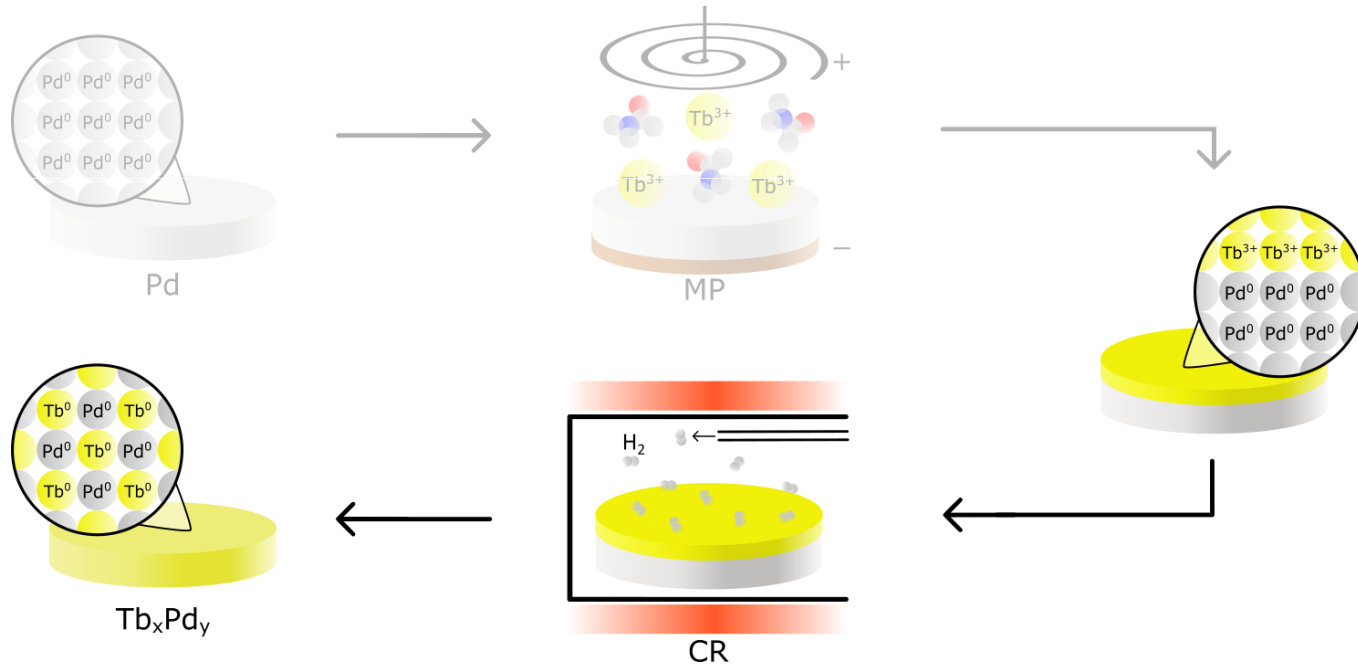


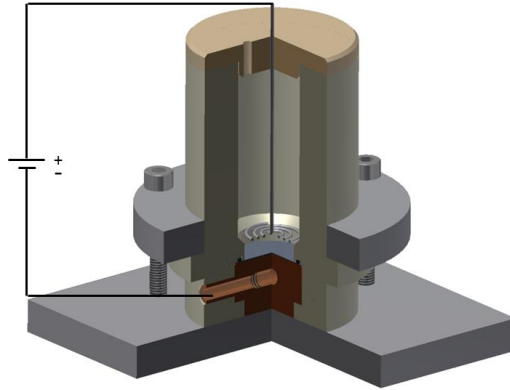
- Alternative to molecular plated targets for the production of SHE with heavy ion beams or for nuclear data measurements
- **Advantages:** better thermal and electrical conductivity as well as better mechanical and chemical stability

Molecular Plating (MP): Deposition of Tb molecular compounds in an organic solvent at high voltages.

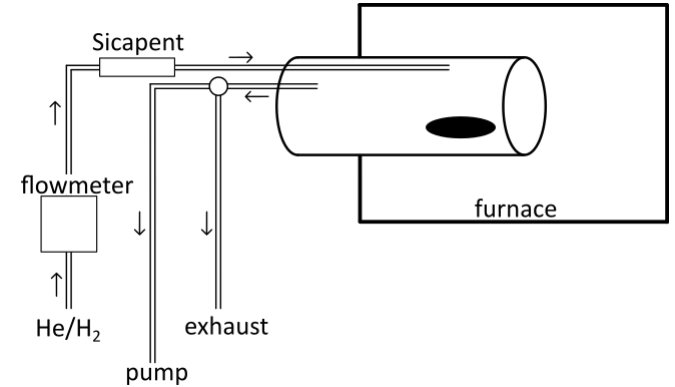


Coupled Reduction (CR): Reduction of Tb and subsequent diffusion through Pd, forming an intermetallic compound.

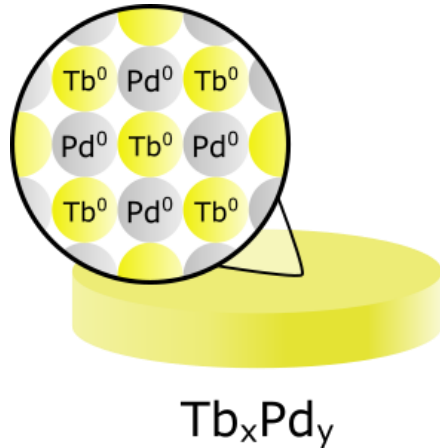




- 5 μL $^{\text{nat.}}\text{Tb}(\text{NO}_3)_3$ (0.311 mg/ μL) in dil. HNO_3
- 5 μL ^{149}Tb (2.05 MBq) in dil. HNO_3 (**α tracer**)
- 10 mL of DMAc
- galvanostatic control at 0.8 mA/cm² for 90 min



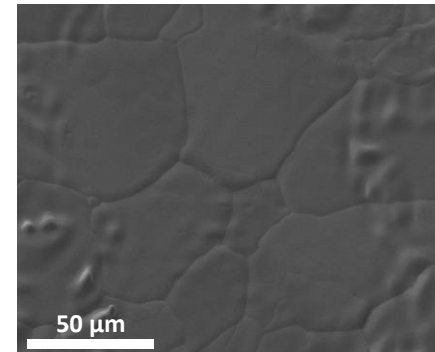
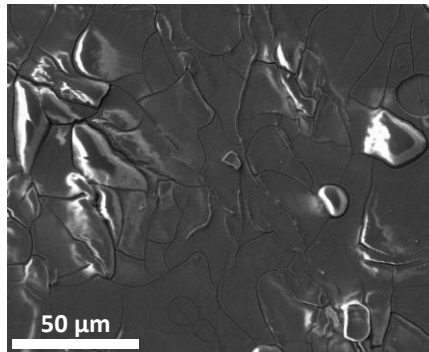
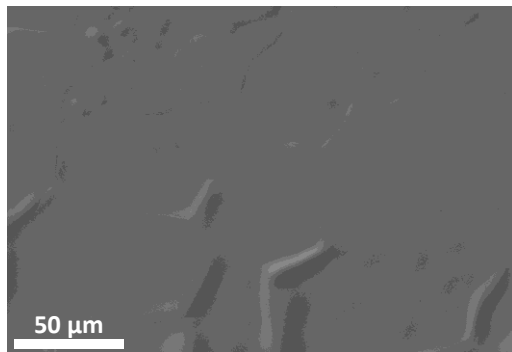
- 25 μm Pd foil
- 100 mL/min H_2 flow
- heating temperature of 1100°C
- heating time of 2 h



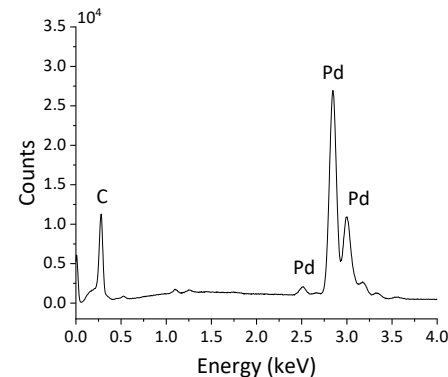
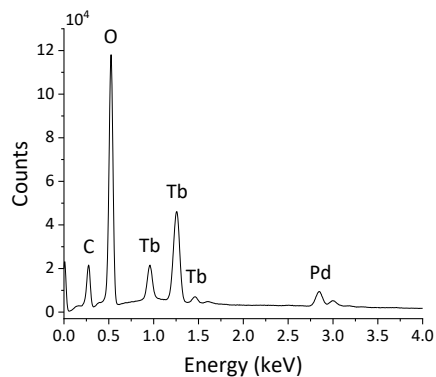
- Morphology: SEM/EDX
- Lateral distribution: Radiography
- Depth distribution:
 - α -spectroscopy and simulation with AASI software
 - transmission XRD using high-intensity synchrotron radiation

Tb 149	
4.2 m	4.1 h
ϵ	ϵ
β^+	α 3.97...
α 3.99	β^+ 1.8...
γ 796	γ 352
165...	165...

Pure Pd



Polycrystalline
microstructure



Assessed by autoradiography (γ -radiation of daughters of ^{149}Tb)

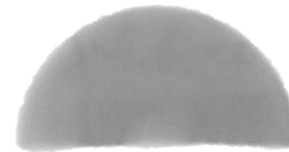
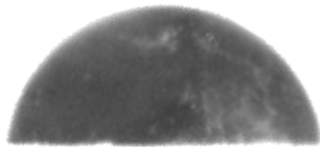
Before CR

After CR

photo



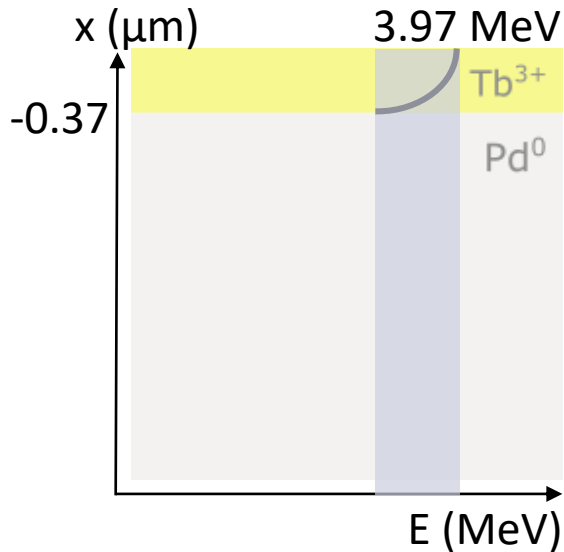
radiography



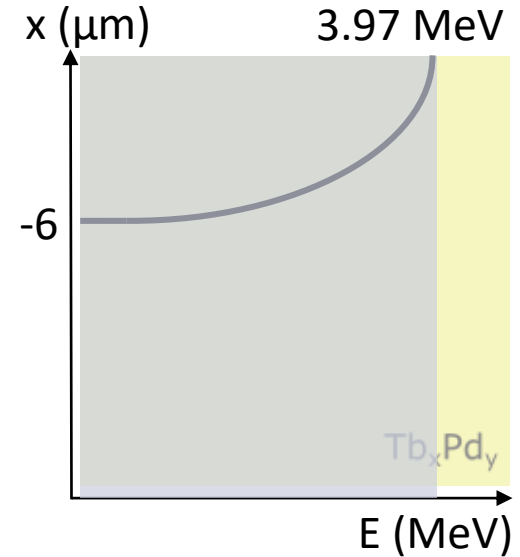
inhomogeneous distribution

homogeneous distribution

- Analyse depth distribution by the energy loss of α -particles (max. penetration depth = 6 μm)

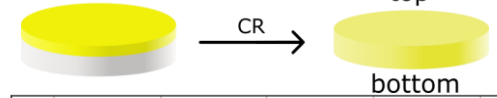
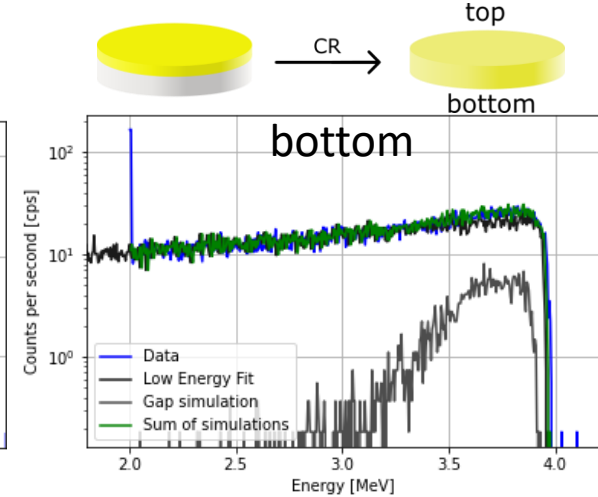
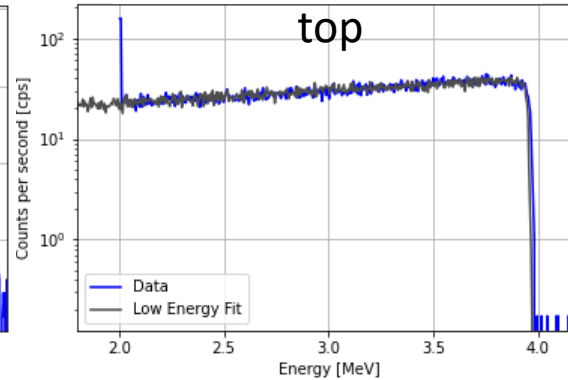
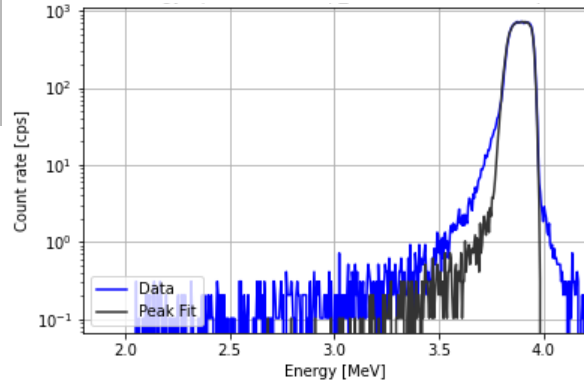


CR \rightarrow



- Model depth distribution with AASI software

Before CR



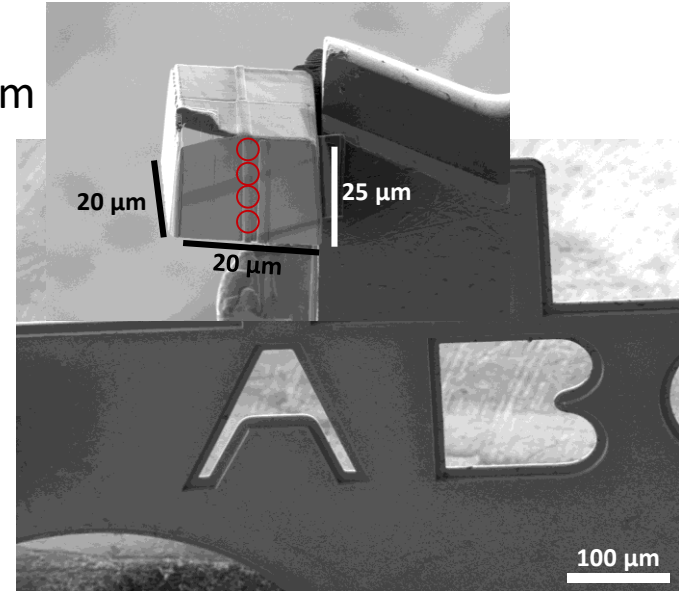
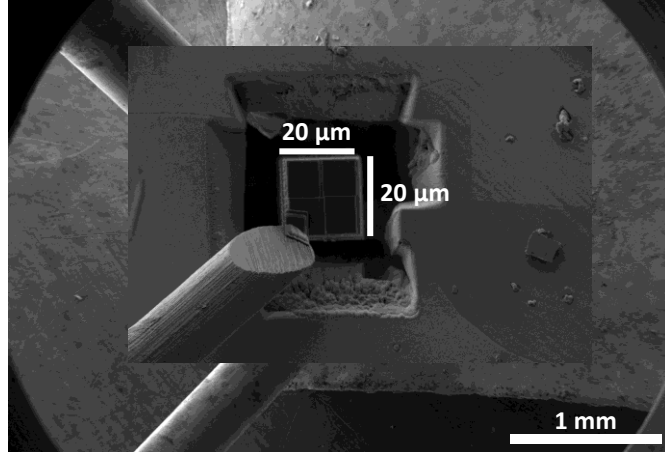
- Simulation covers 97.5% of total number of counts
- Homogeneous distribution with thickness of $0.37 \mu\text{m}$

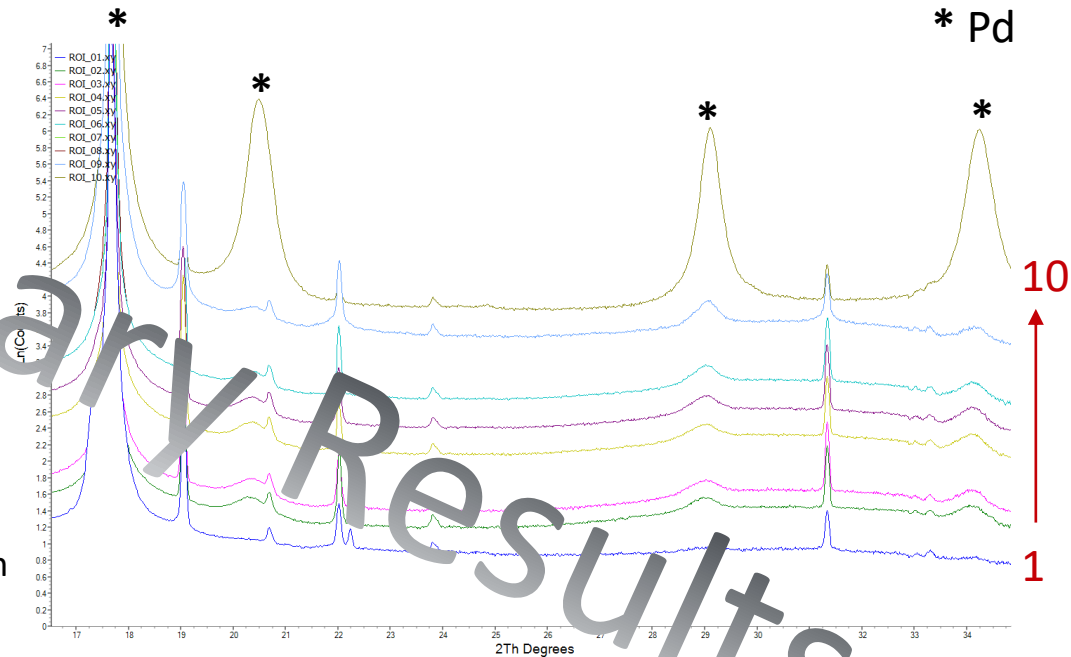
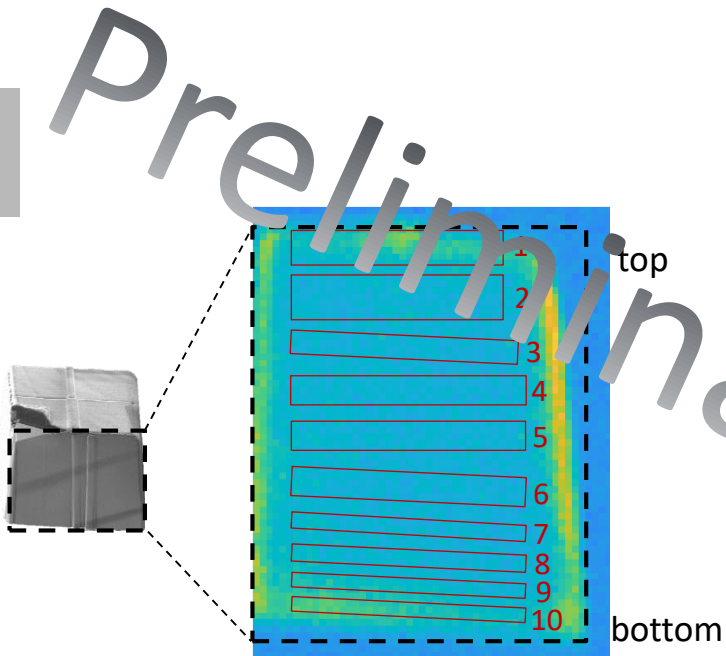
- Top: almost homogeneous distribution into the bulk
- Bottom: similar to top part, but with a slight segregation of Tb at/on the surface
- Activity on top is higher than on bottom

Synchrotron radiation → more precise diffusion analysis than lab XRD

- White or monochromatic light
- Small beam spot size ($< 1\mu\text{m}$)

Sample preparation with Focused Ion Beam





- Pd XRD pattern visible over whole thickness
- Additional XRD pattern → possibly caused by intermetallic

- 2D (radiography) & 3D (α -spectroscopy) homogeneous distribution
- New crystalline phase identified with XRD, which possibly belongs to intermetallic compound
- Possible optimization of CR parameters, such as heating time, backing material, Tb concentration, ...
- Further XRD investigations of plain Pd

My thanks go to



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