



XAS experiment on TiO₂/SiO₂ nanolayered coatings

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1. 背景と研究目的

Large interferometers used for the detection of gravitational waves require mirrors with the lowest possible thermal noise^[1]. For this purpose, various type of materials are continually developed and tested, and recently SiO₂/TiO₂ amorphous nanolayered coatings have been prepared and annealed at different temperatures. Thermal annealing is applied as a standard process to improve optical quality (such as absorption), internal stress and to reduce the coating mechanical losses. On the other hand, annealing can induce crystallization detrimental to the coating optical quality (due to higher scattering by crystallites).

Although Raman and XRD found no sign of crystallization up to 600°C, we propose to use XAS to monitor the occurrence of crystallization (and in case determine which polymorph is formed) possibly not detected by other structural techniques due to the nanometric size of the TiO₂ layers (~2 nm) in the multilayered structure.

2. 実験内容

We measured five multilayer samples, composed of SiO₂/TiO₂ for a total thickness of about 125 nm, grown on Si substrate (0.5 mm thick) as grown and annealed at different temperatures. Measurements were done at Ti K-edge in fluorescence mode, by putting the sample at 45 degree angle respect to the incoming beam and towards the SDD. TiO₂ references materials (rutile, anatase and brookite) were also measured in quick XAFS mode. Finally some samples were also measured in TEY to ensure that the collected fluorescence spectra were not affected by self-absorption effects.

3. 結果および考察

The measured XAS spectra indicate a clear structural change occurring on the sample annealed above 400°C. No significant changes for annealing at higher temperature. By comparing XANES and EXAFS spectra with the ones of reference crystalline materials, we notice strong similarities with the spectral features of rutile TiO₂, although the annealed samples seem to have still an amorphous component. This partial crystallization of a denser rutile phase is interesting since at higher temperature the anatase phase is normally reported. However further investigations, also on other samples prepared with different and optimized deposition parameters are needed to better characterize transitions in these materials.

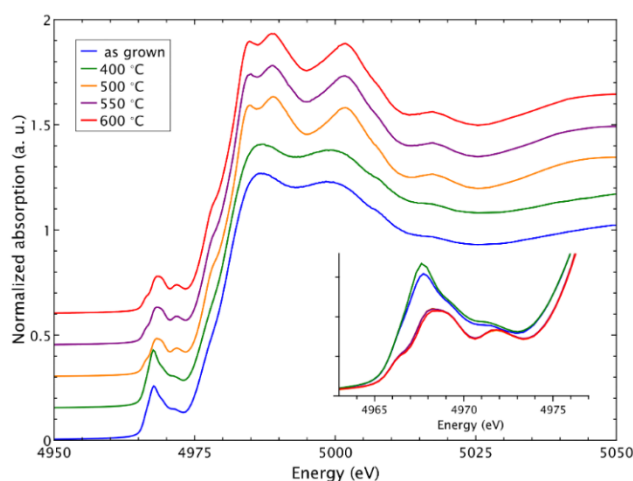


Fig.1 XANES spectra of the measured samples. Inset: zoom of the pre-edge peaks.

4. 参考文献

1. R. Abbott et al., Phys. Rev. X **11** (2021), 021053