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Tomographic X-ray phase and attenuation extraction for a sample composed of unknown materials

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Propagation-based phase-contrast X-ray imaging (PB-PCXI) is a technique suitable for imaging weakly-attenuating objects, e.g., biological samples, as it utilizes both attenuation and refraction effects. Such effects are material dependent, and described by the X-ray's complex refractive index n=1-δ+iβ, where β and δ describe attenuation, and refraction, respectively. Phase retrieval algorithms are typically applied to PB-PCXI images to recover lost phase information. A single-material reconstruction, based on the transport-of-intensity equation, has been published by Paganin et al. [1] and has proven useful in diverse fields. This approach has been extended to consider multi-material objects [2], and partially-coherent X-ray sources [3]. The described phase-retrieval algorithms can successfully recover the projected-phase information of an object, however, they require a priori knowledge of the sample materials. We present an algorithm capable of extracting β and δ functions for a sample that is composed of unknown materials. The essence of the approach is based on curve-fitting an error-function to each interface between distinct materials in a computed tomographic reconstruction [4], where the fit parameters are then used to calculate δ and β for composite materials. This approach requires no a priori sample information, making it broadly applicable, particularly in cases where exact sample composition is unknown. We have applied this method to a breast-tissue sample, where the δ for composite materials was calculated to 0.6% - 2.5% accuracy, compared to theoretical values.

1. D. M. Paganin et al., J.Microsc. 206, 33 (2002)
2. M. A. Beltran et al., Opt.Express 18, 6423 (2010)
3. M. A. Beltran et al., J.Opt. 20, 055605 (2018)
4. D. A. Thompson et al., J.Synchrotron.Radiat. 26, 825-838 (2019)

Level of Expertise

Student

Presenter Gender

Woman

Pronouns

She/Her

Which facility did you use for your research

Australian Synchrotron

Students Only - Are you interested in AINSE student funding

Yes

Do you wish to take part in the Student Poster Slam

Yes

Condition of submission

Yes

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