

# Reflection Zone Plate Spectrometer For Li K Emission Detection In Lithium Compounds

*Khalil Hassebi<sup>1</sup>, Nicolas Rividi<sup>2</sup>, Anne Verlaquet<sup>3</sup>, Alexei Erko<sup>4</sup>, Juergen Probst<sup>5</sup>, Heike Loechel<sup>5</sup>, Thomas Krist<sup>5</sup>, Karine Le Guen<sup>1</sup>, Philippe Jonnard<sup>1</sup>*

<sup>1</sup> Laboratoire de Chimie Physique—Matière et Rayonnement, Faculté des Sciences et Ingénierie, Sorbonne Université, UMR CNRS, 4 Place Jussieu, , 75252 Paris Cedex 05, France

<sup>2</sup>Service Camparis, UMS 7154—CNRS, OSU Ecce Terra, Sorbonne Université, 4 place Jussieu, 75005 Paris, France

<sup>3</sup>Sorbonne Université, CNRS-INSU, Institut des Sciences de la Terre de Paris, IStEP UMR 7193, F 75005 Paris, France

<sup>4</sup> Institut für Angewandte Photonik e. V., Rudower Chaussee 29-31, D-12489 Berlin, Germany

<sup>5</sup>Nano Optics Berlin GmbH, Krumme Str 64, D-10627 Berlin, Germany

Soft X-ray emission spectroscopy (XES) is a technique employed to investigate the electronic structure of materials by analyzing the energy spectrum of x-rays emitted from a sample. The technique involves exposing the sample to ionizing particles, such as electrons, and then measuring the energy distribution of the emitted x-rays. By detecting these characteristic x-rays, we can determine the presence of specific elements and be used for quantitative analysis.

One type of optical dispersive element that can be used in XES is a reflection zone plate (RZP) [1], which is composed of concentric zones of varying thicknesses. RZPs act as diffraction gratings when x-rays are incident upon them, resulting in diffraction and interference of the x-rays, while simultaneously focusing them. Compared to other optical elements like periodic multilayers, RZPs offer higher spectral resolution and can cover wider energy ranges, and can achieve energy resolutions as low as 0.49 eV at the Al L<sub>2,3</sub> line (around 72 eV) [2].

In this study, we employed a Fresnel RZP in an electron microprobe to detect Li K emission in different lithium compounds. Li K emission is a characteristic emission produced when Li 1s levels are ionized in the material. However, detecting this emission can be challenging due to its low fluorescence yield, re-absorption effects, and interference from other spectral lines in the same energy range. We reported the measurement of the Li K emission bands in several lithium compounds using an RZP spectrometer, demonstrating the potential of this approach for various applications in x-ray spectroscopy.

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## References

[1] A. Erko *et al.*, *Opt. Express*, vol. 22, no. 14, p. 16897, Jul. 2014, doi: 10.1364/OE.22.016897.

[2] A. Hafner *et al.*, *Opt. Express*, vol. 23, no. 23, p. 29476, Nov. 2015, doi: 10.1364/OE.23.029476.