ESRF	**Experiment title:** Electron-Phonon Coupling in High-T_c Bismuthates	**Experiment number**: HC-4182
Beamline:	**Date of experiment**: from: 13 Apr 2021 to: 19 Apr 2021	**Date of report**: 24 Oct 2022
Shifts:	**Local contact(s)**: Davide Betto, Nick B. Brookes	*Received at ESRF:*

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Report:

A) Overview

The mechanism of high-temperature superconductivity in bismuthates ($Ba_{1-x}K_xBiO_3$ or $BaBi_{1-y}Pb_yO_3$) remains a subject of intense debate [1]. Whether the unexpectedly high superconducting transition temperature T_c originates from electron-phonon coupling [2,3], or, is alternatively dominated by electronic interactions [4] is central to the controversy. The key to differentiate these scenarios is to quantitatively determine the electron-phonon coupling (EPC) strength in this system which has been a challenging task. We therefore carried out an O *K*-edge RIXS experiment at ID32 to measure the phonon excitations in single crystal $Ba_{1-x}K_xBiO_3$, $x = 0.4$. Utilizing the unique sensitivtiy of RIXS phonon cross section to the EPC, we have successfully obtained RIXS spectra that allow us to estimate the EPC strength in this system which has been a long-standing debate. A manuscript reporting these results is currently in preparation. Local contacts Davide Betto and Nick B. Brookes will be included as coauthors for their substaintial contributions to this work.

B) Experimental results

Due to the three-dimensional cubic crystal structure, the $Ba_{1-x}K_xBiO_3$ single crystals are known to be very difficult to cleave and thus far no RIXS data has been reported on the single crystal form of this material. We have overcome this technical difficulty and successfully obtained satisfactory and consisent RIXS spectra on several cleaves. Given the three-dimensional nature of the system, rotation of the scattering angle is necessary to reach specific wave vectors that are of interest. Linear vertical incident light polarization was used to enhance the RIXS phonon cross section. Instrumental energy resolution has been set to 30 meV and 15 meV for the purpose of ehancing intensity and resolving fine excitation structures, respectivley.

Figure 1 (a) displays a RIXS intensity map as a function of energy loss and incident phonon energy at **Q** = (0.2, 0.2, 0.2), which is the highest momentum that can be reached along the high-symmetry (*h*, *h*, *h*) direction. Low-energy resonant features are observed around incident energy Ei = 528.5 eV. At higher energy loss of around 2 to 6 eV, fluorescence excitations are observed. For the study of the EPC, we focus at the low-energy part of the RIXS spectra. As is shown in Fig. 1(b), the RIXS spectrum between -50 to 200 meV can be analyzed with four Gaussian components with peak width constraint by the instrumental resolution: an elastic line at zero energy loss and three excitation modes at ~20 meV, 65 meV and 130 meV, respectively. By the comparison with the phonon spectra obtained from non-resonant inelastic x-ray scattering [5], we assign the ~65 and ~130 meV excitation modes to the bond-streching phonon and its second harmonic, respectively. The intensity ratio between the first and second phonon is fitted to be $I_2/I_1 = 0.21$. Applying the Ament model [6], we obtain the dimensionless EPC g = 2.3.

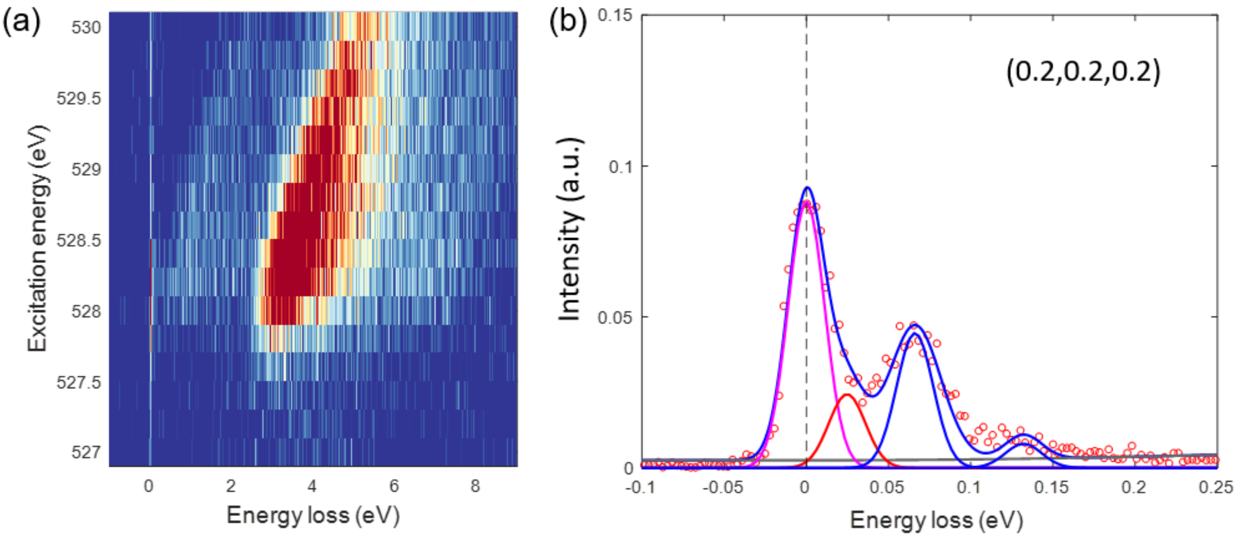

Fig. 1. (a) RIXS intensity map versus enerlgy loss and incident exictation energy at **Q** = (0.2, 0,2, 0.2). (b) Low-energy part of the RIXS spectrum at **Q** = (0.2, 0.2, 0.2).

C) Publication

We are paparing a manuscript report data obtained from this beamtime. Given the significant scientific question that is addressed in this study and the technical challenge that has been overcome, we expect the result to be of strong impact in the field of superconductivity and correlated systems. Therefore the manuscript is planed to be submitted to high impact journals like Physical Review Letters.

References

[1] A. W. Sleight, Physica C 514, 152 (2015).

[2] T. M. Rice and L. Sneddon, Physical Review Letters 47, 689 (1981).

[3] A. S. Alexandrov et al., Physical Review B 54, 3655 (1996).

[4] G. Zhao et al., Physical Review B 63, 220506(R) (2001).

[5] H. Khosroabadi et al., Physical Review B 83, 224525 (2011).

[6] Ament et al., Europhys. Lett. 95, 27008 (2011).