# Octahedral Tilting in $SrRuO_3$ Films Studied by Half-Order Reflexions

Wenlai Lu[1], Ping Yang[2], Gan Moog Chow[1]
Jingsheng Chen[1]

1. *Department of Materials Science and Engineering, National University of Singapore, Singapore 117576, Singapore*
2. *Singapore Synchrotron Light Source (SSLS), National University of Singapore, 5 Research Link, Singapore 117603, Singapore*

Octahedral tilting has been of great interest since it is intimately linked to the electronic structure and thus the physical properties of $ABO_3$ perovskite oxides. Recently, there are reports on the modification of octahedral tilting in $SrRuO_3$ films either by strain engineering [1] or by varying film thickness [2]. Despite the extensive studies on the crystal structures of $SrRuO_3$ films, direct evidence for the accurate octahedral tilt system is missing.

In our study, half-order reflexions have been employed to investigate the octahedral tilting in $SrRuO_3$ films. According to Glazer [3], there are basically two types of tilt: tilts where octahedra rotate in-phase along one axis, denoted by the superscript +, and tilts where the octahedra are rotated out-of-phase, denoted with the superscript -. The in-phase and out-of-phase tilt about a particular axis can be easily distinguished by the presence of odd-odd-even type and odd-odd-odd type peaks. As shown in Figure 1, the presence of $^1/_2$103 and $^1/_2$105 peaks implies that there are in-phase tilts about [010] axis, denoted by $b^+$. The absence of $^1/_2$013, $^1/_2$015 peaks and existence of $^1/_2$113, $^1/_2$115 peaks indicates that the rotations about a axis are out-of-phase, denoted by $a^-$. Similarly, there are purely – tilts about c axis, indicated by the absence of $^1/_2$132, $^1/_2$312 and the presence of $^1/_2$133 peak. Considering the equality of lattice parameters $a_c$ and $b_c$ based on the pseudocubic cell, the tilt system is immediately determined to be $a^-a^+c^-$, which is consistent with the tilt system inferred from the lattice parameter measurements as reported previously [1].

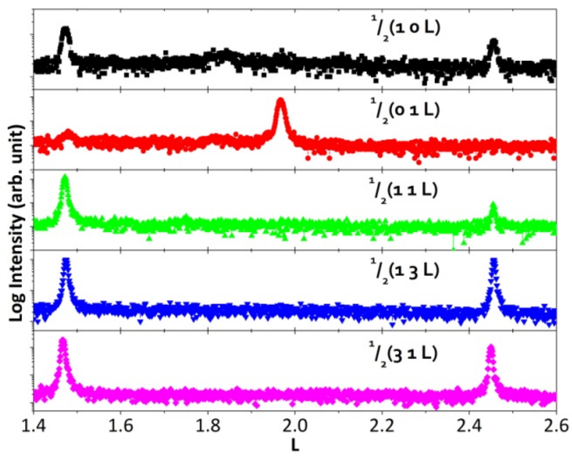


**Fig. 1.** L scans of $^1/_2$(1 0 L), $^1/_2$(0 1 L), $^1/_2$(1 1 L), $^1/_2$(1 3 L) and $^1/_2$(3 1 L) around half-order peaks in the $SrRuO_3$ films deposited on $SrTiO_3$ substrates. The tilt system is determined to be $a^-a^+c^-$ from the half-order peaks.

These results show that the measurement of half-order peaks is a straightforward approach for determining the octahedral tilt system and can be applied to other perovskites.

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