# Synthesis and time-resolved studies of the stability of $LaMO_3$ perovskites in acid

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Perovskites have been in the spotlight for the last decade due to their potential as energy materials [1]. Specifically, La-based transition metal oxide perovskites ($LaMO_3$) present promising results as electrocatalysts to substitute the common scarce and costly noble-metal-based ones [2]. However, their large-scale implementation is limited by their rather poor stability in the operating conditions [3]. Elemental doping or substitution, with highlight of high entropy oxides (>5 elements), are some of the approaches proposed to stabilise these materials. If we aim to increase their usage in industrial settings, a deeper understanding of their degradation mechanisms is of critical interest.

Here, we propose a systematic study of the stability of $LaBO_3$ perovskites in acidic media (e.g., HCl 6M). We synthesised and tested multiple perovskites with different B-site compositions, including the presence of 1, 3 or even 5 different transition metals in the B-site crystallite lattice. We studied the effects of the different metals in the lattice and depicted trends from the combination of these. Our custom-made synchrotron *in situ* flow-cell allowed us to collect time-resolved scattering data, containing information of the degradation in the second-scale. From the total scattering data, we follow the loss of crystallinity of the oxides. Moreover, pair distribution function (PDF) analysis allows us to track the structural changes occurring in the short-range and thus follow the selective leaching of certain elements.

For example, we have observed how perovskites containing Ni and/or Co completely collapse after 2 hours of treatment (Figure 1), whereas the presence of Fe in the lattice slows down the dissolution, increasing the stability significantly. Furthermore, due to the complex thermodynamic structural landscape of perovskites, the degradation leads to second-order phase transitions in some of the multimetallic compositions. We anticipate that our study can be of great value, bringing detailed knowledge on the stability and degradation mechanism of these materials, for their future applications in operational conditions.

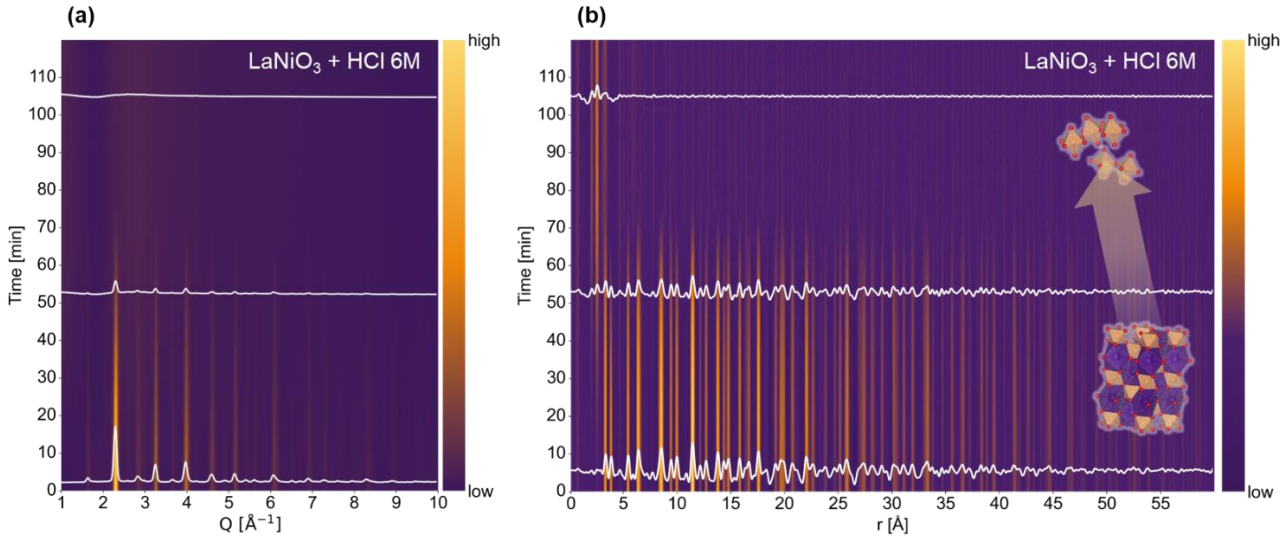



***Figure 1.*** *Time-resolved (a) total scattering and (b) pair distribution function (PDF) for the reaction of $LaNiO_3$ with HCl 6M. Inset in (b) proposes the degradation of the perovskite.*

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