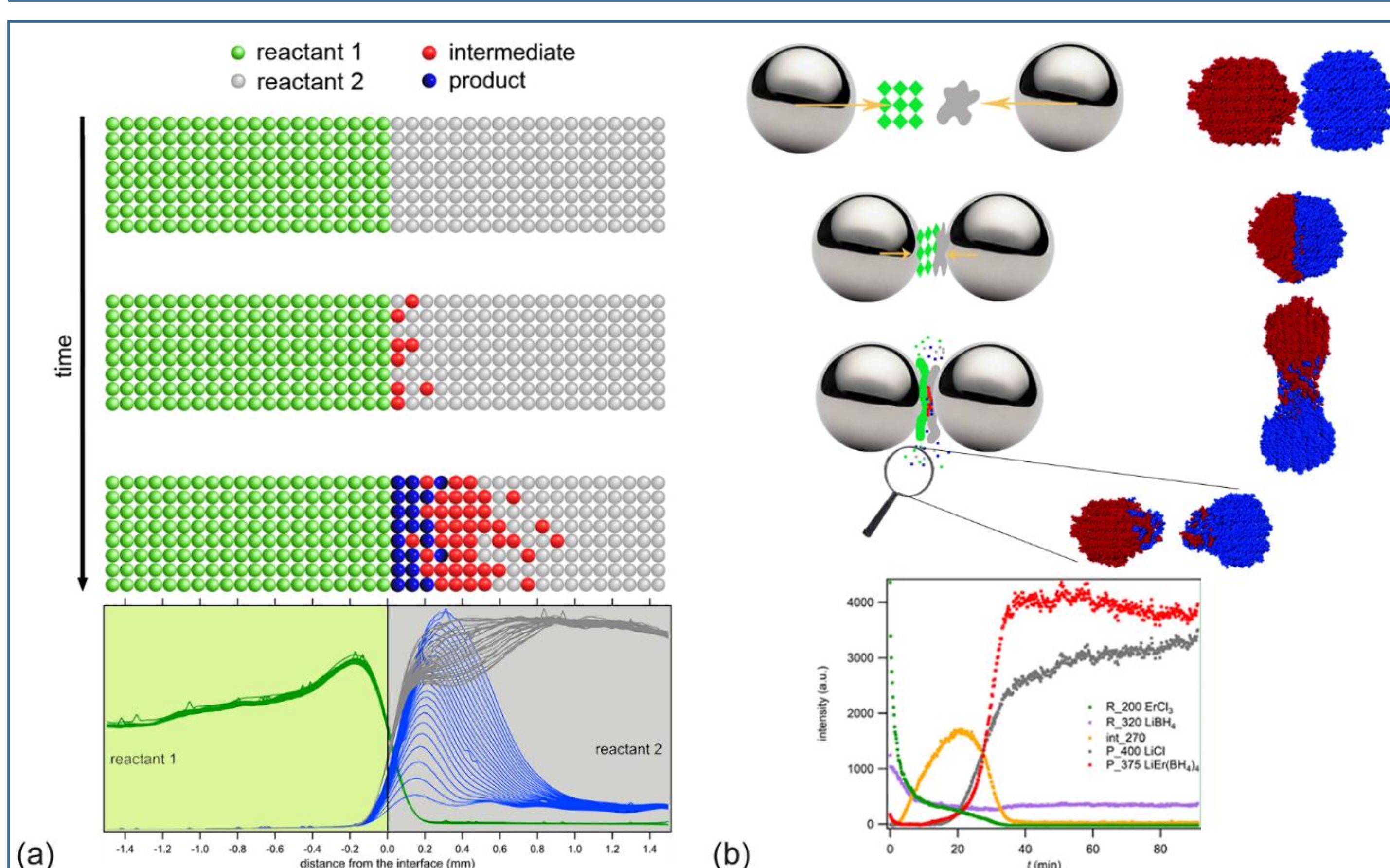
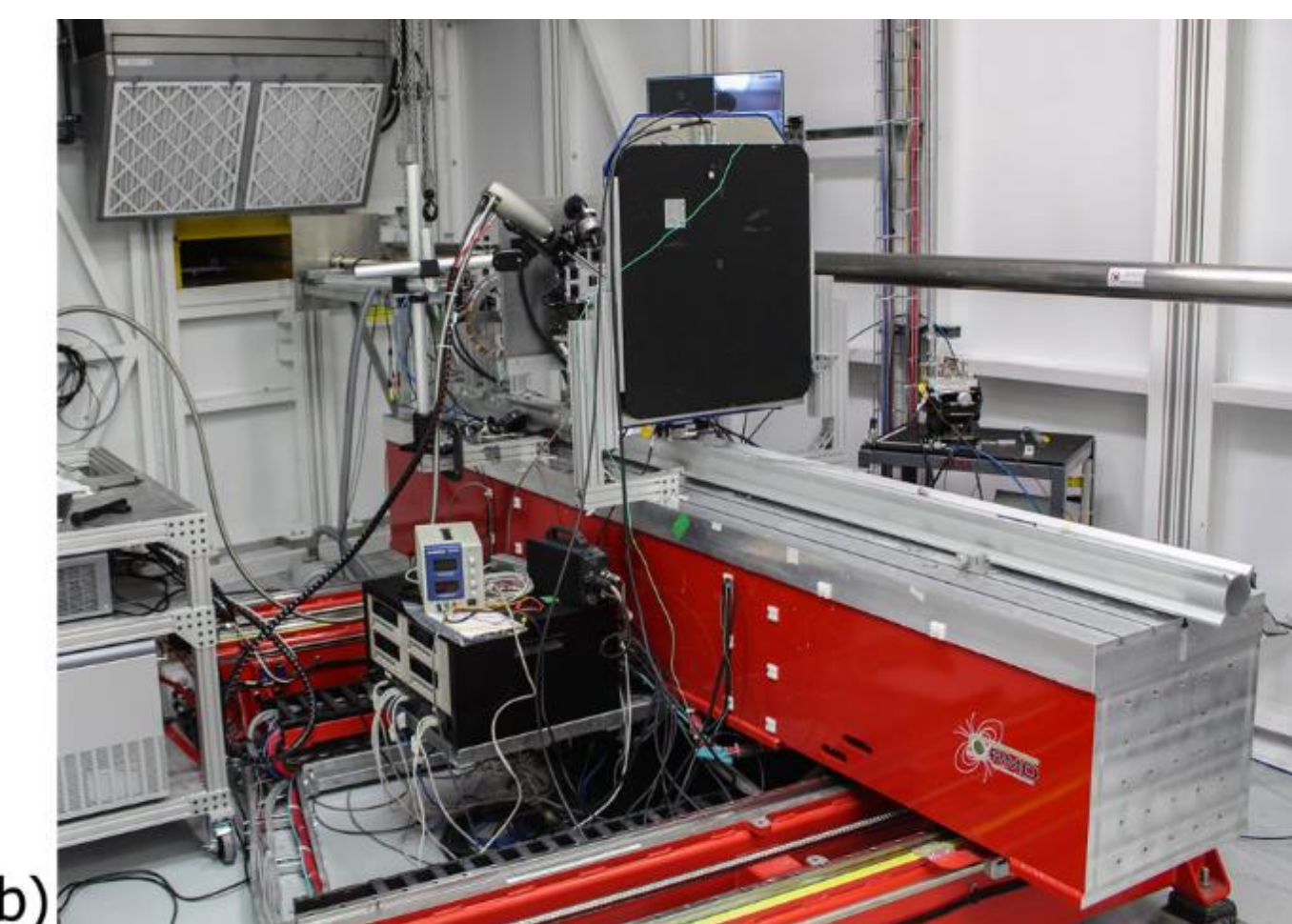
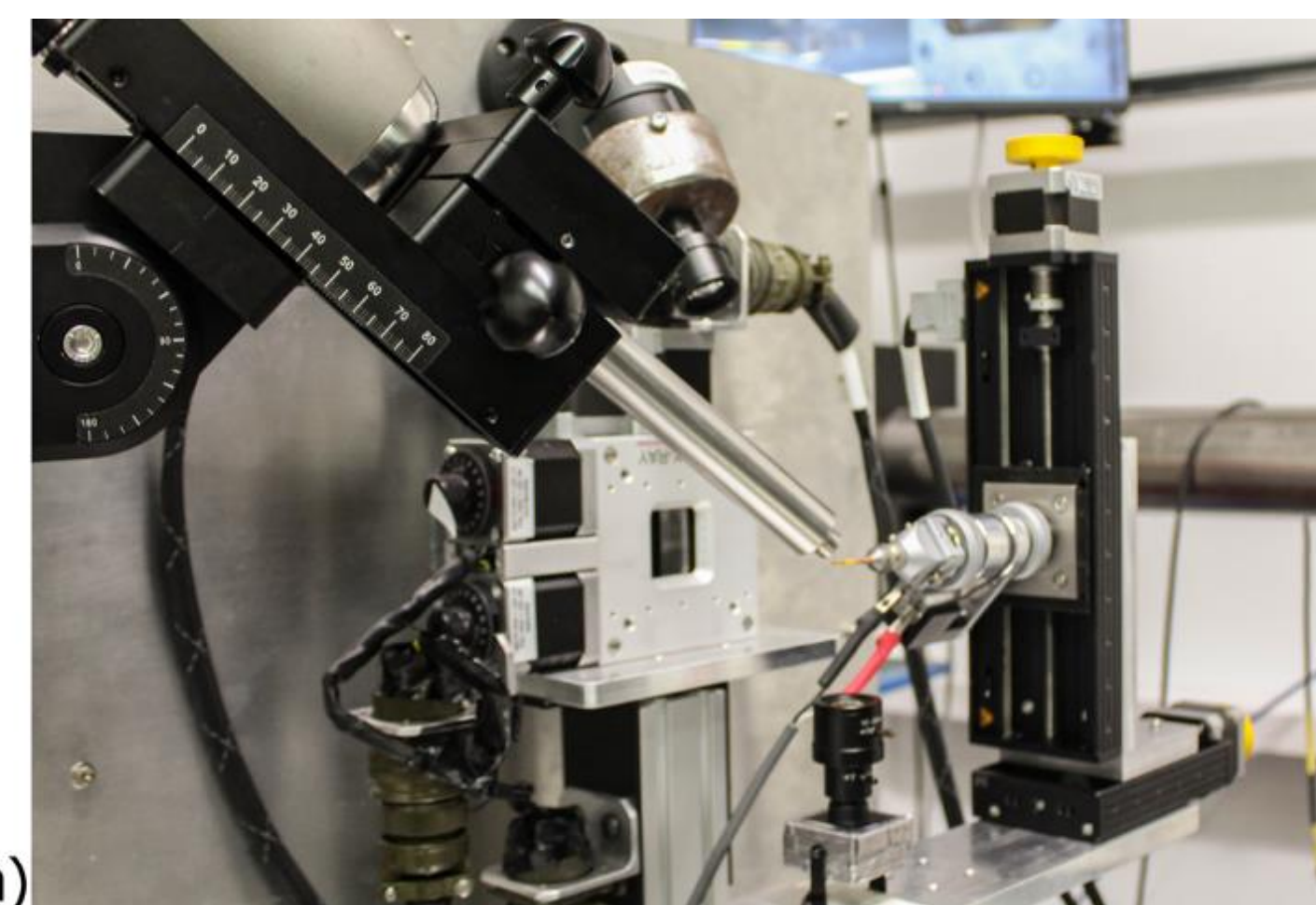


# Fluid and quasi-fluid intermediates in solid-state reactions

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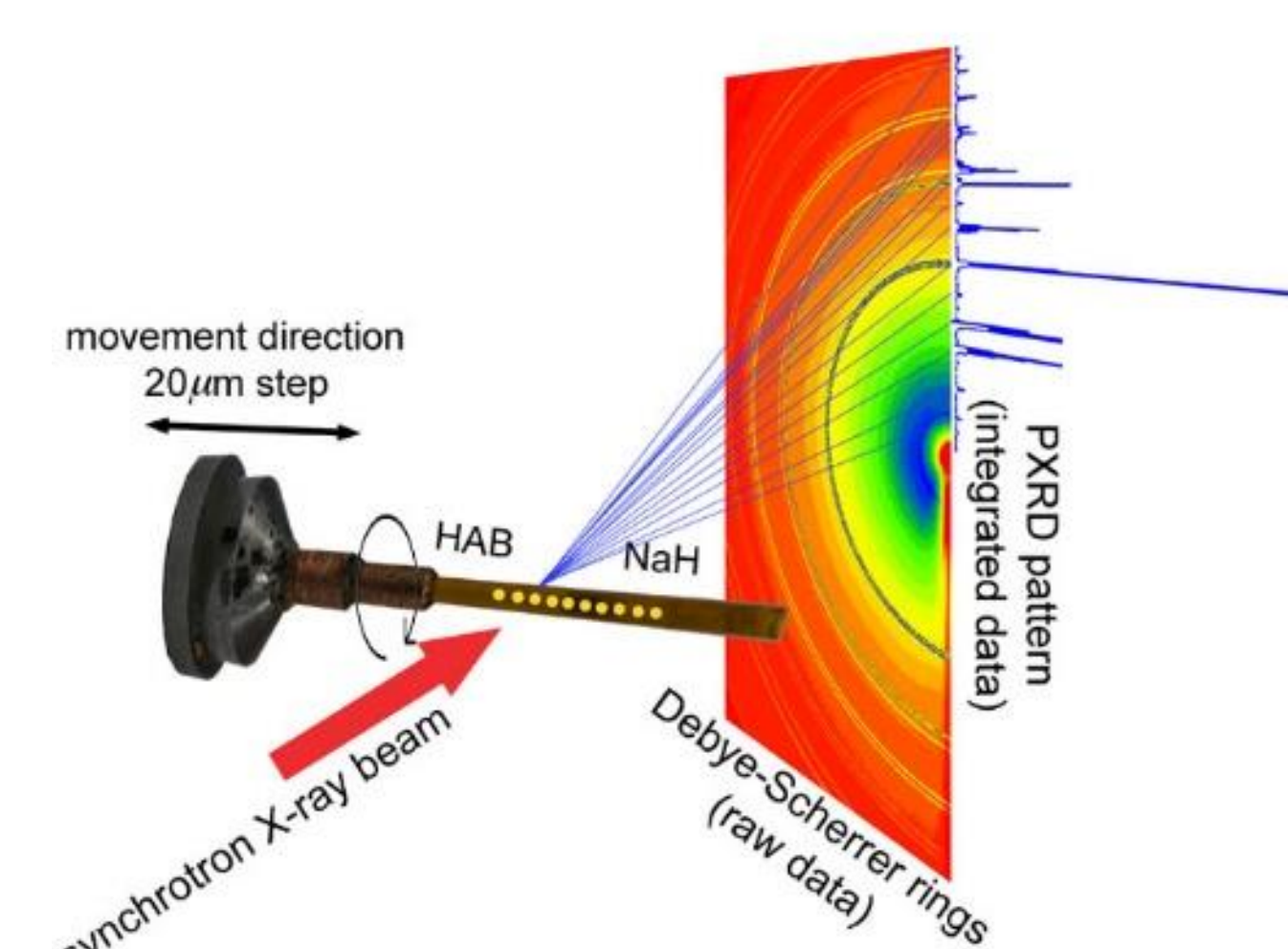
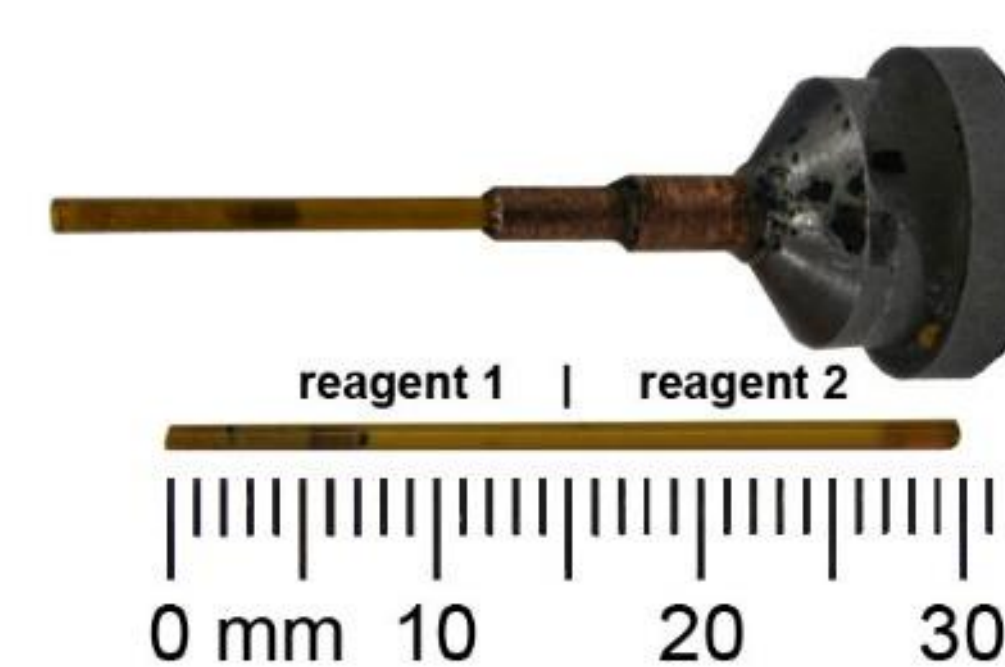
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Any chemical reaction requires mobility of reactants to allow their collisions. This implies an active role played by regularly observed amorphous phases in the first stages. They are a medium that enables mobility of involved species, making a chemical reaction possible. It is also clear that solid-state chemical reactions are initiated by the contact of reactants on the interface. However, this fundamental aspect has not been dealt with in sufficient detail so far. Study of macroscopically static reactions on well-defined interfaces, and their spatially and temporally resolved chemical mapping will enable clarification of mechanistic details.



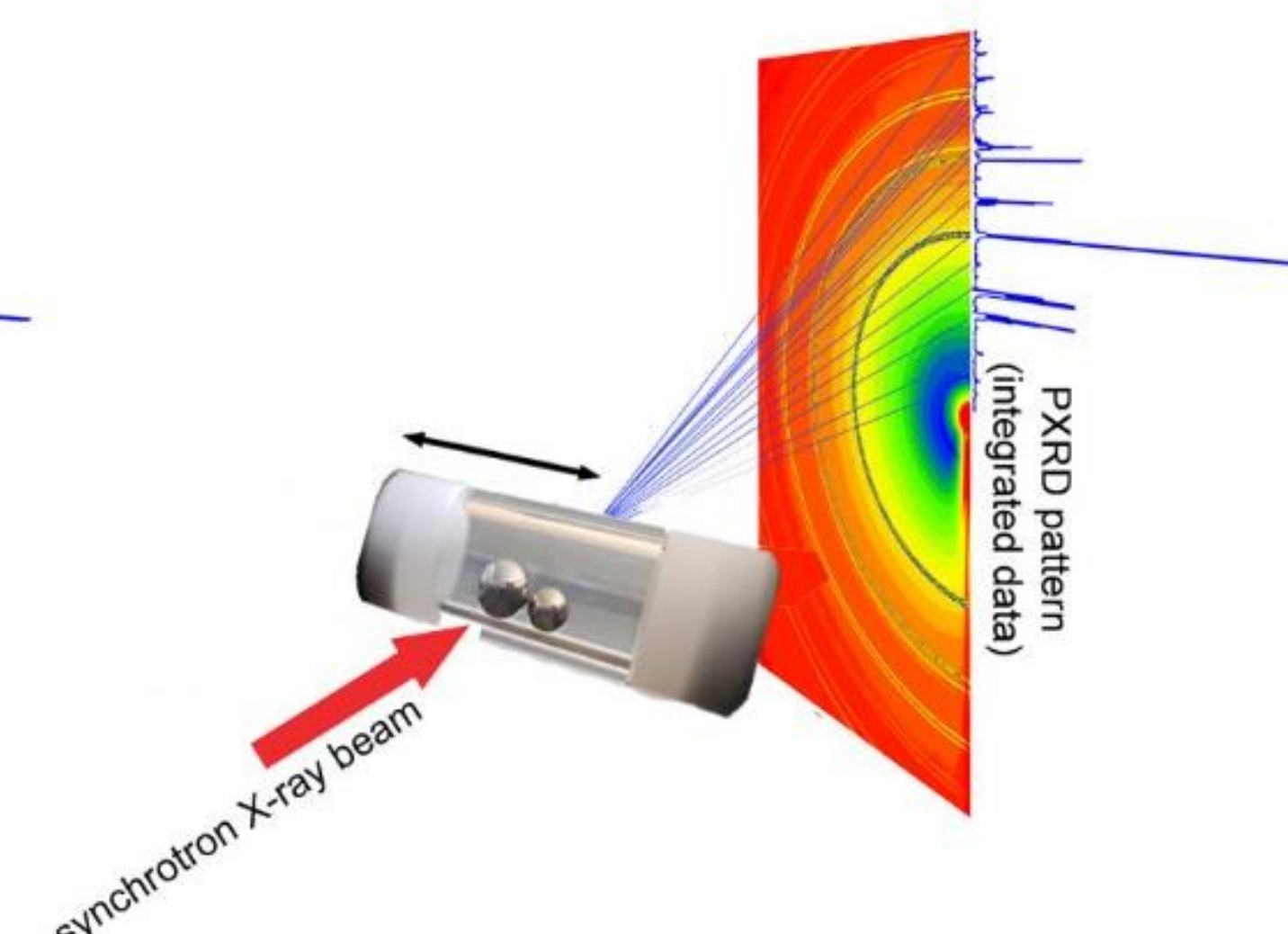
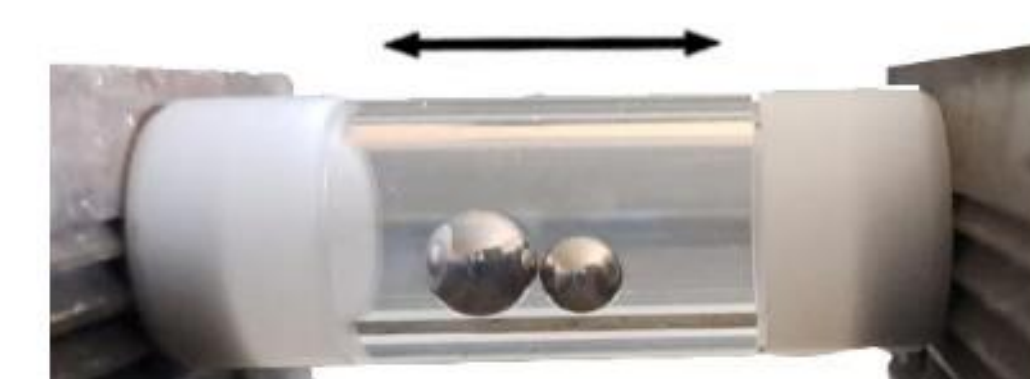
Processes on solid-solid interface. (a) Static reactions - macroscopically immobilized reactants are initially brought to contact on well-defined interface. After a certain time formation of amorphous intermediate takes place. Being a medium enabling good mobility of involved species, this amorphous intermediate enables chemical reaction. (b) Dynamic reactions - external kinetic energy is constantly transferred to reactants, fragmentating them to grains, thus constantly changing exposed intergrain interfaces, where the processes take place. However, interdiffusion of involved reactants is dramatically promoted by decreasing grain size (MD snapshots taken from Ferguson et al.). Below the reactions schemes, representative reaction profiles are shown.

## Interface reactions



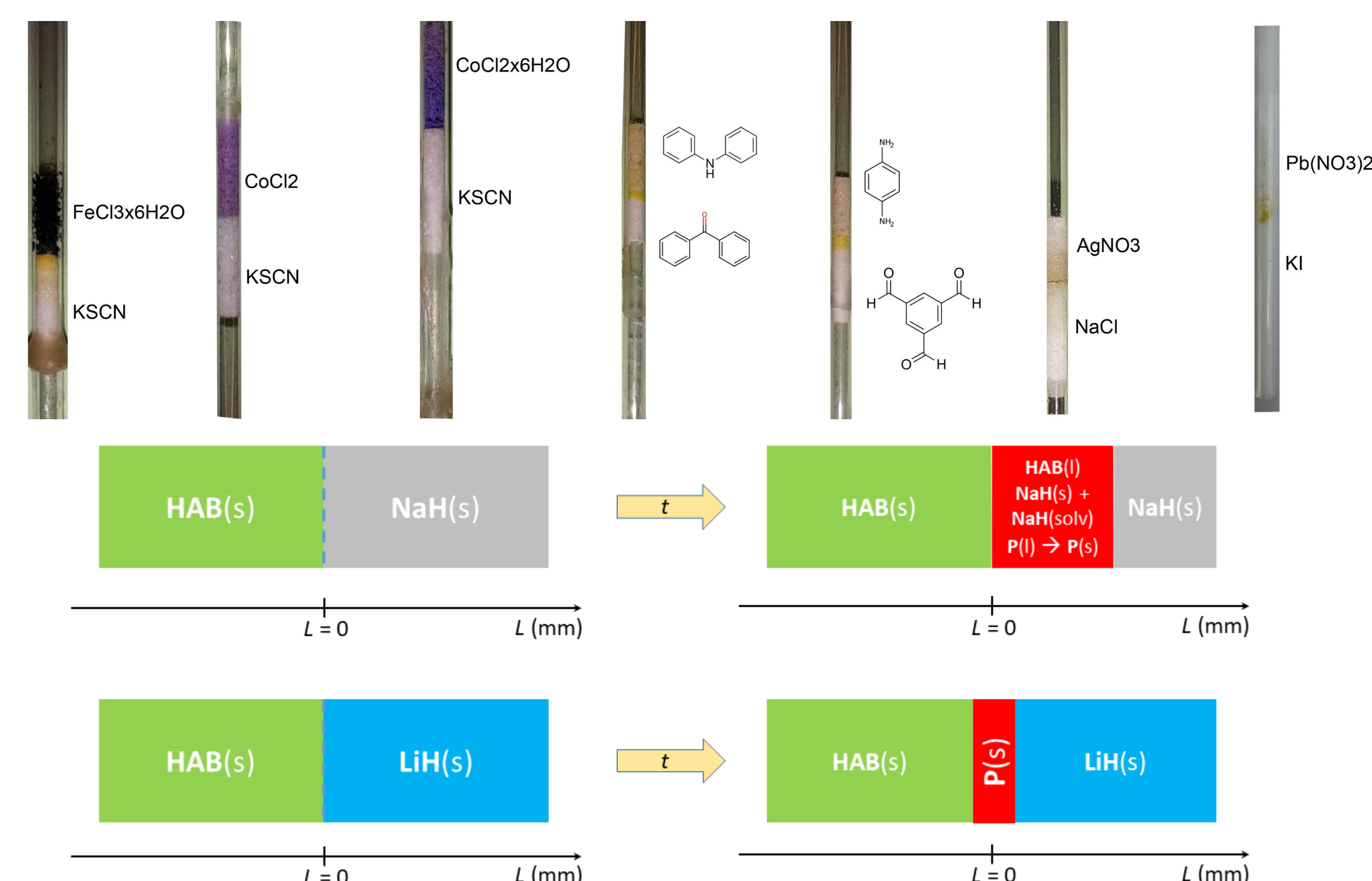
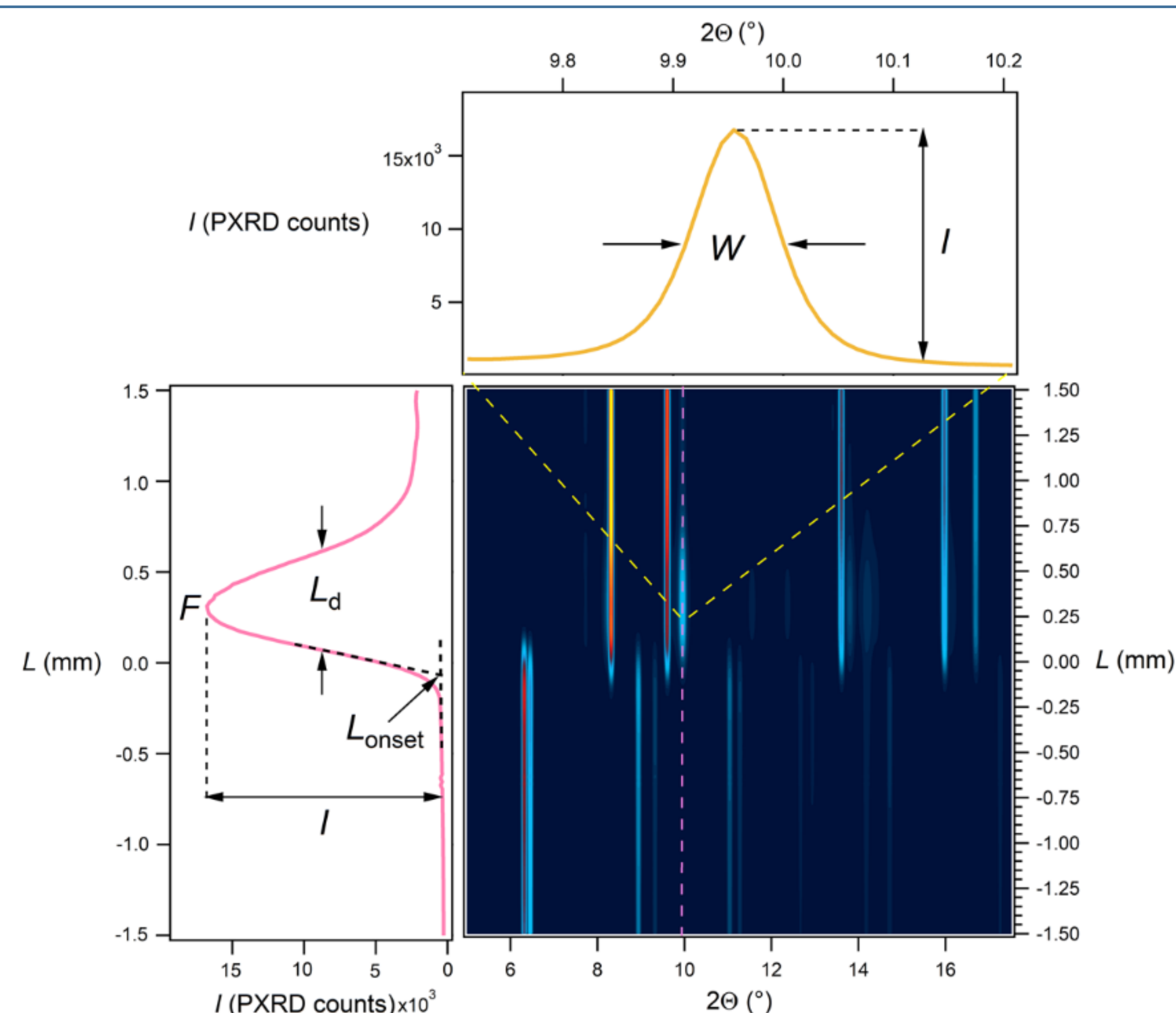
(a)

## Liquid-assisted grinding



(b)

Synchrotron PXRD monitoring of (a) interface reactions, with respect to the distance from the interface between reactants. Capillary is filled with reactants in contact at the interface, and each measurement is taken stepwise at a separate distance from the interface. Measurement is resolved in space and time; (b) ball milling reactions. The individual measurement was performed in-situ. The general measurement principle is the same for both systems: synchrotron X-ray beam passes through the sample, and a diffraction image is acquired on a 2D detector.



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