Use of Small-Angle Scattering for the characterisation of precipitates in metallic alloys.

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Small-Angle Scattering is one of the oldest techniques for characterising nanometre-scale precipitates in metallic alloys. However, the increasing access to high flux and high resolution synchrotron X-ray sources has considerably widened the possibilities of this technique. The present contribution will summarize some of the recent progress we have achieved on metallic alloys :

1. Understanding non-isothermal precipitation using in-situ measurements during fast temperature changes. The competition between precipitate dissolution and transformation of metastable to stable precipitates during continuous heating of AlZnMg alloys will be presented, and compared to modelling results.

2. Characterisation of the precipitation state in weld heat affected zones by microstructure mapping. The effect of initial microstructure and welding parameters on the 2-D distribution of precipitate microstructures will be shown in the case of Friction Stir Welding of aluminium alloys. It will be shown that this microstructure distribution enables to understand the weld mechanical behaviour.

3. Determination of the heterogeneous chemical structure of precipitates in AlZrSc alloys using high sensitivity measurements. It is now well accepted that in the AlZrSc system precipitates consist of a Sc-rich core and a Zr-rich shell. It will be shown that SAXS enables to quantitatively determine the parameters of this peculiar structure (thickness, composition, .) and that these parameters can thus be followed in-situ during a variety of heat treatments. The unusual precipitation kinetics of this system will be discussed.

4. Perspectives on the evolution of precipitation under the combination of stress/strain and temperature will be given, through preliminary results obtained using a specific stage developped in our laboratory.