Bimetallic nanoparticles are gaining attention in the field of catalysis, exhibiting strongly enhanced activity and selectivity compared to their monometallic counterparts. The synergy is achieved by mixing a very active metal (normally Pd or Pt) with a less active metal (Au), that slows the reaction rate and provides selectivity to the system. However, atomic distribution inside a nanoparticle is dynamic and it can drastically change under catalytic reaction conditions, such as high temperatures or exposure to gases. The overall aim of my PhD project is to establish direct correlations between the structure and catalytic behavior of core-shell structured nanoparticle catalysts. To achieve this, I use a combination of colloidal synthesis, advanced TEM and catalytic testing.

The first key aim of my PhD is to study the impact of restructuring in bimetallic nanoparticles on their catalytical performance. For this, we use in situ transmission electron microscopy (in situ TEM), which with modified TEM sample holders allows imaging with the presence of gas at atmospheric pressure [1]. This allows monitoring the position of the elements in a single nanoparticle and determine the redistribution kinetics. Specifically, I use *in situ* TEM to watch atomic restructuring in well-defined Au-Pd core-shell nanoparticles upon exposure to common reaction gases. Pd is known to segregate to the surface under an oxidative atmosphere, which increases hydrogenation activity since surface palladium is necessary for H2 dissociation [2]. We are visualizing and quantifying the alloying dynamics *in situ* in H2 and O2.

The second key aim is to quantify the effect of strain induced on the Pd atoms by the core-shell structure with 4D STEM. Core-shell structures in Au-Pd nanorods have been found to be more active and selective in the butadiene selective hydrogenation than their monometallic counterparts [3], due to strain and electronic effects induced on the Pd-shell by the underlying core. In this project, we locally quantify the lattice strain in the Pd-shell using 4D STEM - an advanced electron microscopy technique – and correlate it to the H2 dissociation activity, which is an elementary step in many hydrogenation reactions. This outcomes of this project will contribute fundamental understanding of the origins of the enhancement catalytic performance of the core-shell nanoparticles.