# Autonomous manipulation and reactions in Scanning Probe Microscopy

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Scanning Probe Microscopy (SPM) has been the engine of characterization in nanoscale systems in general, and the evolution of functionalized tips as a reliable tool for high-resolution imaging without material restrictions has been a breakthrough in studies of molecular systems. In parallel, machine learning (ML) methods are increasingly being applied to data challenges in SPM. In particular, the success of deep learning in image recognition tasks has led to their application to the analysis of SPM images, especially in the context of surface feature characterisation and techniques for autonomously-driven SPM. In this work, we explore the general potential of ML approaches to be used actively during SPM experiments for analysis, both in terms of feature recognition and chemical and electronic characterisation [1]. We extend this to demonstrate the autonomous construction of nanostructures through atomic and molecular manipulation, and also explore automated construction of more complex molecular systems atom-by-atom and bond-by-bond [2,3].

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