Rapid development and miniaturization of electronic devices observed in recent years forces to search for an alternative to current technology. One of the concepts is based on application of organic materials like graphene nanoribbons, nanographenes or 2-dimensional molecular nanoarchitectures. They could be regarded as promising candidates for versatile tailor-made organic materials potentially applicable in (opto)electronics, spintronics, gas storage or chemical sensing. The development requires toolkits for efficient fabrication with reproducibility down to single atom level. In this context the so-called "on-surface" synthesis is a promising approach for tailor-made materials. Despite the undoubted success several limitations still act as bottle-necks blocking synthesis of functional nanostructures or their applications. For instance application of large or chemically active/unstable molecular precursors that cannot be deposited by standard techniques would open new fields of exploration. Development of synthetic strategies out of the metallic surfaces, which frequently provide catalytic activity, is also a major challenge and its overcoming would increase the applicability of desired nanostructures on technologically most relevant semiconducting and insulating surfaces. Given the challenges the project will be focused on bringing into practice two important strategies boosting the on-surface synthesis: (1) - Implementation of the new deposition approach, which enables usage of large and/or fragile/unstable molecular precursors; (2) - Combination of atomic and/or molecular gas reagents with precursors sublimed onto crystalline substrates from evaporators.

The novel approach will introduce new concepts to build nanodevices from large or unstable molecular precursors. Furthermore we will apply atomic gases for precise modification of molecular structures on surfaces to develop a versatile route for in situ doping, defect repairing, isotope substitution and fabrication of new, extended graphene nanomaterials. Important step will be related to the extension of on-surface generated graphene-based architectures on the basis of molecular heteroatomic gas reagents, which could fulfil the desire for the synthesis of large graphene flakes - unsubstituted and free of side protecting groups, which cannot be achieved through traditional wet chemistry. Finally, the most challenging, yet most desirable goal would be to set a new catalyst-free synthetic strategy in order to get rid of the need to base on the role of a metallic substrate. This is planned to be achieved by using atoms that activate chemical reactions and are supplied from the gas phase. In particular, activating the appropriate functional groups that will be embedded within specially designed molecular precursors in order to induce chemical reactions and further transfer of the strategy onto semiconducting/insulating surfaces would provide the most appealing scientific results and open up the possibilities for fabrication of molecular nanoarchitectures on technologically most relevant substrates. The project is on the forefront of research focused on surface assisted synthesis of extended graphene-like nanoarchitectures and seems to be attractive both from the scientific and technological point of view.