Scientific innovations and rapid technological progress require the development of novel materials with specific properties. Many materials available on the marked may not satisfy all requirements, and must be functionalized or combined into heterostructures. Such functionalized or hybrid materials often are superior to those of bare components.

Silicene is one of novel two-dimensional material composed of silicon atoms arranged into a honey-comb lattice. Its atomic structure is reminiscent of graphene. It also has similar electronic properties which come from the linear band structure, known as the Dirac cones. So far silicene has been synthesized in the epitaxial form, mainly on surfaces of metals. However, the presence of a metallic substrate may substantially modify electronic structure of silicene, even destroy the Dirac cones. On the other hand, the substrate is a powerful tool to functionalize silicene. Strong silicene-substrate interaction may induce new energy bands, which in turn may result in exotic properties of novel silicene-based heterostructures, superior to those of bare components. By using specific substrates, the properties of these Dirac excitations can be controlled and further tuned.

The project aims to combine the ultimate two-dimensional material – silicene and one-dimensionally ordered support – Au covered stepped Si substrates to produce novel Dirac materials with strongly anisotropic characteristics. The goal of the project is to determine mechanisms responsible for the formation and modifications of these exotic fermion excitations in novel Dirac materials in the form of complex anisotropic Si-Au heterostructures.

Such novel Si-Au heterostructures can easily be chemically functionalized by the adsoroption of foreign atoms. Thus advanced novel functional materials with tailored characteristics can be designed and synthesized.

The silicene itself has attracted a considerable attention of scientists and engineers also for its potential applications in the next-generation nanoelectronics, as it could easily be integrated with the present electronics based on silicon. Indeed, first field effect transistors based on silicene have already been designed and fabricated. Silicene-based hybrids, like novel anisotropic Si-Au heterostructures proposed in the present project, can substantially strengthen the position of silicene on the stage of advanced two-dimensional materials.