Popular science summary:

The project is devoted to studying the electrical properties of graphene heated up to 500 °C. In general synthetic graphene has two forms – flake or foil. The first has the form of tiny flakes and has been accepted as valuable addition to a range of composites. The latter stretches over a distance of centimetres. It has potential in electronics and is a point of interest in this project.

Of all ways to produce foil graphene one method is of special importance – deposition on a crystal called silicon carbide. Silicon carbide is a compound semiconductor made of silicon and carbon atoms. It is often used in high-voltage and high-current electronics. Graphene on silicon carbide has a key advantage over many other graphene technologies, including graphene on copper - it does not require transfer. Copper conducts electricity. The silicon carbide substrate is purposely made semiinsulating and it does not conduct electricity. For this reason graphene need not to be detached and moved onto a non-conducting substrate. This property is very favourable and makes it suitable for the technology of electronic devices.

It turns out that graphene has one remarkable feature – it retains its electrical properties even when heated up to very high temperatures. It is likely a material that could enable high-temperature electronics. One can imagine magnetic field, current, power and chemical detectors or even analog or digital circuits operating up to 500 °C. However, graphene cannot float in the air. It needs to rest on a certain substrate. In case of silicon carbide its semiinsulating character is only retained to around 300 °C. Above this temperature the substrate starts to conduct electricity. At 300 °C the effect is negligible but as the temperature gradually approaches 500 °C it becomes prominent enough to affect graphene's properties.

It is expected that silicon carbide substrates offered by different manufacturers react differently to the temperature rise, and so should their influence on the graphene layer. Also it is anticipated that one can knowingly modify the silicon carbide substrate to change the way it conducts electricity when heated up. Moreover, it is not only the substrate that affects graphene. Graphene requires some kind of passivation, a layer of material that does not conduct electricity and is placed on top of it to protect it from the ambient atmosphere. The way this protective layer affects graphene also depends on temperature and this mechanism requires detailed analysis.

The project will answer fundamental questions: how is graphene affected by different silicon carbide substrates and different passivation materials as we heat it up to 500 °C? Is it possible to modify the silicon carbide substrate and the passivating material to affect graphene in a purposeful manner?

In order to answer these questions graphene will be grown on silicon carbide, its quality will be inspected with sophisticated microscopes that reveal details imperceptible for an unaided eye. Graphene devices will be fabricated and their electrical properties analysed. Many of the methods will require graphene to be heated up to 500 °C.

With all the knowledge and experience we will be able to conclude whether electronic devices made of graphene could operate at very high temperatures, potentially met in automobile, aerospace, mining, military and space industries.