Over the past decade, the relaxed graded SiGe buffer has enabled the development of a multitude of novel CMOS-compatible strained-Si, -SiGe, and -Ge heterostructure platforms with enhanced carrier transport properties relative to bulk Si. However, one significant drawback to the relaxed graded SiGe buffer platform is the low thermal conductance of such a structure. This results in a local temperature increase near the device channel, a condition known as the self-heating effect. This self-heating effect is especially pronounced in high-power devices and can lead to significant reductions in both mobility and drain current.

As possible solutions to this self-heating problem, we report the creation of two CMOS-compatible platforms for high-power applications: strained-silicon on silicon (SSOS) and strained-silicon on silicon-germanium on silicon (SGOS). SSOS substrate has an epitaxially-defined, strained silicon layer directly on bulk silicon wafer without an intermediate SiGe or oxide layer. SSOS is a homochemical heterojunction, i.e. a heterojunction defined by strain state only and not by an accompanying compositional change, and therefore in principle SSOS may ease metal-oxide-semiconductor (MOS) strained Si fabrication as SiGe is absent from the structure. SGOS has an epitaxially-defined SiGe layer between the strained silicon channel and the Si substrate, which is necessary to prevent excessive off-state leakage in MOS devices due to overlap of the source-drain contacts and the interfacial misfit array. Plan-view transmission electron microscopy revealed edge-type interfacial misfit dislocation arrays with an average dislocation spacing of approximately 40 nm for both structures. This spacing indicates that the strained Si layer of SSOS is fully strained and that the SiGe layer of SGOS is fully relaxed. Complete relaxation of the intermediate SiGe layer in SGOS was confirmed by Raman spectroscopy, and since this layer is thin (<100nm), its inclusion is not expected to detrimentally affect the overall thermal conductivity of the structure.