Interface roughness in quantum cascade lasers. Popular Introduction.

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Coherent radiation sources (lasers) are devices that have a lot of applications in the modern world. Lasers are used in data storage (optical disc readers), communication infrastructure (fiber-optic Internet), fabrication of various materials and also in spectroscopy. Spectroscopy (the investigation of light after its interaction with matter) can be used to deduce the composition of investigated samples. Since only photons (light particles) of specific energies are absorbed by atoms or molecules, photons of different energies must be used to investigate different materials. Therefore there is a strong reason for developing lasers radiating light at various wavelengths (energies).

Certain ranges of the electromagnetic spectrum are covered by high quality, well developed lasers. However, there exists a gap where laser coverage is poor. The range in question is the mid-infrared and terahertz frequencies. The traditionally used lasers for these wavelengths perform poorly at room temperature (therefore require cooling by liquid nitrogen) or are extremely expensive. In 1994 a new principle for lasing was demonstrated: the quantum cascade laser (QCL). These lasers provided an additional option to cover the mid-infrared and terahertz wavelength range. Two decades after the first realisation of the QCL, the mid-infrared quantum cascade lasers have reached the point where industrial applications are widely used. These lasers can operate at room temperature and are thus suited for everyday use. Terahertz lasers are not there yet, but a lot of effort is being made to improve them.

However, quantum cascade lasers are complicated structures and there are still a lot of gaps in our understanding of these devices. A big effect on the performance of the QCL is due to the interface roughness scattering. The influence of interface roughness is not understood in detail, but there are indications that high interface roughness strongly inhibits the lasing. The aim of this work is to investigate several mechanisms at work in a laser with interface roughness and how they affect the performance of quantum cascade lasers by performing simulations of the structure.