Master thesis proposal

Sputtered AlN layers for UV and nonlinear photonics

Background

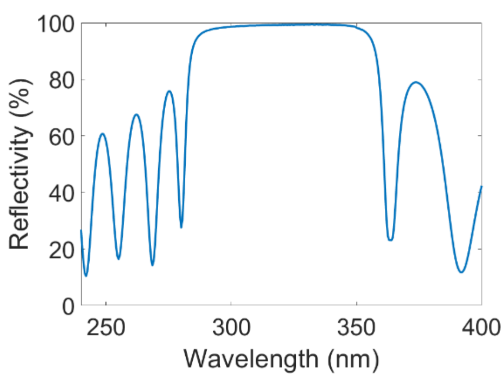
Aluminum nitride (AlN) holds a big potential for various applications in photonics. Its wide bandgap makes it transparent over the entire near-infrared, visible, and ultraviolet (UV) spectral range, down to 210 nm. This makes it an ideal material for devices operating in the UV, such as highly reflective distributed Bragg reflectors (DBRs) for UV lasers or resonant-cavity light-emitting diodes. The non-centrosymmetric crystal structure of AlN allows both second- and third-order nonlinear optical processes, such as second-harmonic or frequency comb generation. However, monocrystalline AlN can only be grown on a limited number of substrates (most notably sapphire), limiting the heterogeneous integration of AlN in photonic devices.

Thesis scope

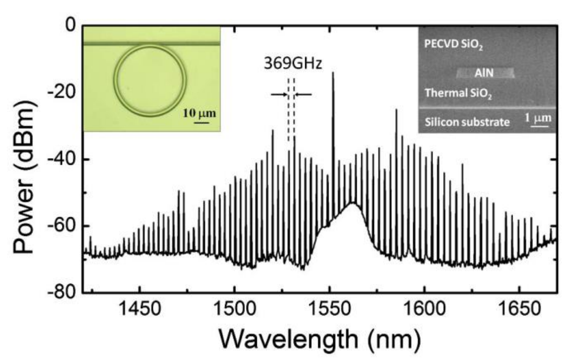
The goal of this thesis is to develop polycrystalline AlN layers deposited by magnetron sputtering. This technique allows to deposit layers on almost any substrate, providing a large flexibility for the integration of such layers in many device architectures. The polycrystalline character induces structural defects in the material, leading to absorption and surface scattering, especially for short optical wavelengths. You will therefore optimize the layers to have low absorption in the UV and low surface roughness, in order to make them suitable for UV applications. Depending on the interests and time-restrictions of the student, the project could be extended to the development of UVC-DBRs with these layers.

Methods

You will work in Chalmers' state-of-the-art cleanroom facilities at the Department of Microtechnology and Nanoscience. You will use magnetron sputtering to deposit the AlN layers, atomic force microscopy to characterize the surface roughness with atomic precision, as well as ellipsometry and spectrophotometry to measure the optical absorption in the layers.



Reflectivity of a UVB-DBR



Frequency comb (main figure) generated from an AlN ring resonator (insets). Jung *et al.*, Optica 1 (2014)

This work will be conducted within the Wide-bandgap Semiconductor Group at the Photonics Laboratory, Department of Microtechnology and Nanoscience. For more information, please contact

Joachim Ciers (joachim.ciers@chalmers.se), room B440
Åsa Haglund (asa.haglund@chalmers.se), room B437