Sub-micronic resonant grating filters realisation on large surfaces

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Guided-Mode Resonant Filters (GMRF) constitute a new family of ultra-selective and wavelength-tunable spectral filters useful for applications from optical telecommunications to spectroscopy. Using only a few nanostructured layers, it allows complex optical filtering functions, hardly accessible to conventional thin films filters [1, 2]. They are generally fabricated by stacking layers on a glass substrate to perform filtering, guiding and coupling/decoupling functions with a sub-λ grating. The tunability of the central wavelength is generally obtained by varying the angle of incidence but the main issue is to maintain performances of the filter independently of the polarization of the incident light as to be used with unpolarized or uncontrolled light. Another challenge lies in the realization of the nanostructures themselves

Those sub-micronic dimensions are easily accessible with standard microelectronic tools like stepper lithography but the complex optical response in the case of transparent substrates distorts automatic alignment systems of projection optics. On the other hand direct-writing structuration technique (electronic lithography) are long and less reproducible for surfaces more than a few hundreds of µm².

An interesting alternative lies in the use of Nano-Imprint Lithography (NIL) that allows to mechanically imprint a mold in a thermoformable (or UV-crosslinkable) resin. This approach avoids contrast issues from optical technique and allows printing on large surfaces with a good conformity and resolution down to tenth of nanometers.

We can take advantage of the long experience on stepper lithography to fabricate high-quality Si hard-mold (up to 6" in our case) nanostructured by a desired grating (period 880nm) on the whole surface. Once this mold fabricated, it can be transferred at will on glass samples – either partially or totally – using a soft-mold UV-imprint intermediary step in a home-made curable resin (NIL-UV135 [3]).

We demonstrate a mature pathway for the realization of tunable spectral filters from the conception to the optical characterization. Those filters can be realized on large surfaces (up to 6'' diameter wafers) and have been tested in simple 1D and 1D-crossed grating configuration. They present high reflection intensity (70-90%) on a wide accordability range (1500-1600nm at least) with thin spectral width (≈1.5-2nm) and high rejection rate (<5% outside of reflection peak).

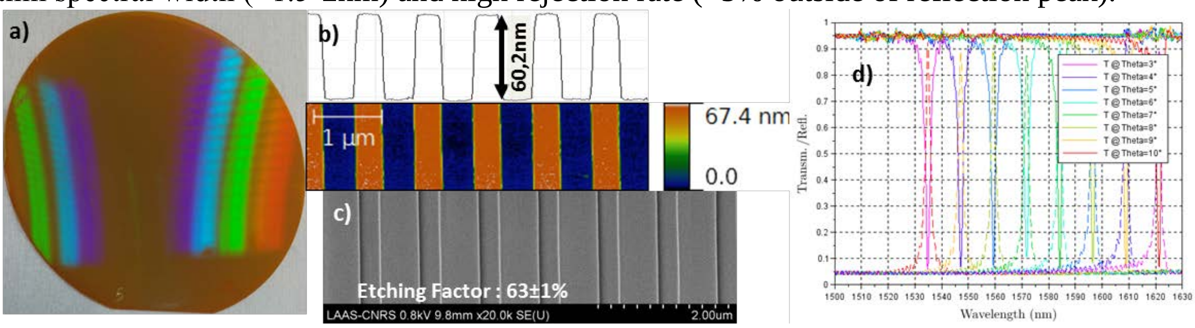

Figure: (**a**) sub-micronic SiO_2 gratings fabricated at the LAAS-CNRS on a multilayer 2x[SiO_2/a-Si] on glass 4" substrate. AFM (**b**) and SEM (**c**) measurements to control quality of the gratings. (**d**) Transmission/Reflection θ-2θ measurements on such filters (up to 90% reflected signal, tunability : 12.3nm/°, spectral width around 1nm)

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[2] A. Monmayrant, S. Aouba, K. Chan Shin Yu, P. Arguel, A.-L. Fehrembach, Optics Letters ; 39/ 20 (2014)
[3] H.Makhloufi, E.Daran, J.B.Doucet, G.Lacoste, A.Larrue, O.Gauthier-Lafaye, C.Fontaine, JNMO (2013)