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Ion Beam Sputter Etching and Deposition with Carbondioxide

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We present ion beam sputtering by a Kaufman type gun with CO_2 working gas as an universal tool both for dry etching of III-V compounds and for deposition of high band gap metal oxides, which e.g. play an important role as optical coating and passivation layers.

The etch procedure works well for several kinds of binary, ternary and quaternary III-V compounds with etch rates differing by a factor of 3 at most. Even InP, which has one of the most critical surfaces concerning degradation and roughening is smoothly etched by this method with an etch rate > 100 nm/min (at $U_B = 800$ V, $J_B = 1$ mA/cm^2). An etch selectivity > 40 is achieved against titanium mask material.

CO_2-ion beam sputtering of Al, Ti and the refractory metals Hf, Nb, Ta and Zr yields deposits of the corresponding oxides. The films formed on different single and polycrystalline substrates prove to be amorphous, they adhere excellently. SEM pictures reveal a featureless dense fracture and a smooth surface. Despite a certain content of carbon (up to 9 at% for titaniumoxide [1]) the films are highly transparent in the visible and near infrared wavelength range. Refractive indices determined by ellipsometry cover a range from n = 1.63 (Al_2O_3) (Fig. 1) to n = 2.35 (Nb_2O_5) and allow the build up of interference filter stacks of alternating low and high index layers[2].

As an application 980 nm-pump lasers for EDFAs are AR-coated on the front facet and HR-coated on the rear one. The AR-coating consists of a single $\lambda/4$ layer of Al_2O_3, the HR-coating is realized by stacks of Al_2O_3/TiO_2 layers. Influences on quantum efficiency and threshold behaviour will be reported.

[1] B. Kempf, to be published in Proceedings of the MRS Fall Meeting, Boston 1993

[2] M. Ettenberg, Appl. Phys. Lett. **32**(1978)11, 724

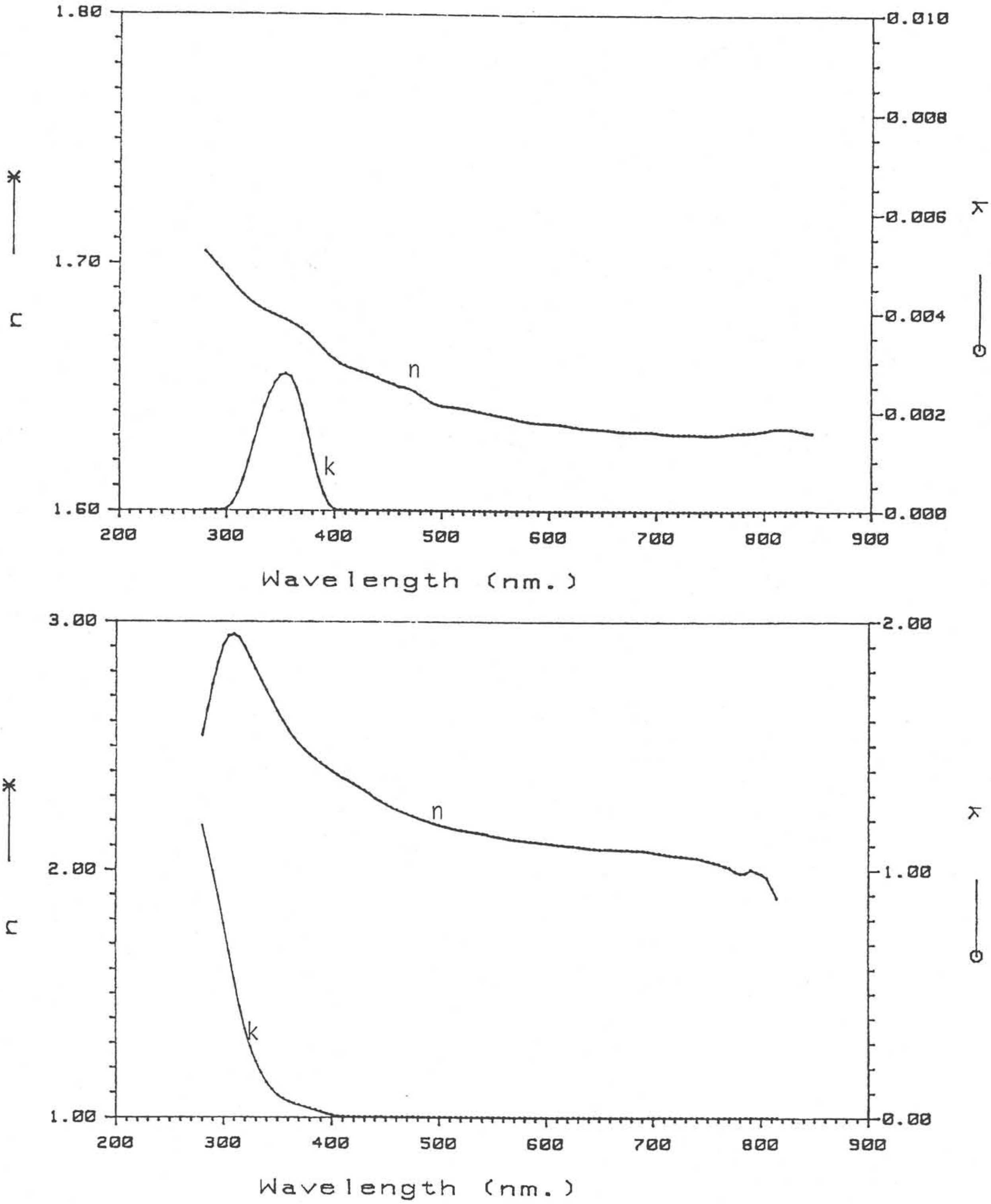

Fig. 1: Dispersion of refractive index n and extinction constant k
for two CO_2-ion beam sputtered oxide layers.
top: aluminumoxide
bottom: titaniumoxide