PULSED LASER DEPOSITION WITH ULTRA-SHORT PULSES USING HIGH REPETITION RATE LASERS

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Pulsed laser deposition, PLD, is a versatile method for thin-film deposition. The method was first studied in the 1960's, only a few years after the demonstration of the first lasers. Succesful depositions of high-temperature superconductor thin-films in late 1980's started a boom in the research of the PLD. During the 1990's deposition of various materials by nanosecond laser pulses were reported. Until now, a vast majority of such depositions has been done by excimer lasers with nanosecond pulse widths.

Deposition with nanosecond pulses requires precise control of various laser parameters; including temporal shape of the pulse, beam profile and intensity distribution. In many cases, meeting all these requirements at the same time is a formidable challenge. Therefore, the quality of the deposited films is often impaired with a formation of droplets and nanoparticles. During the last ten years, however, the use of ultrashort pulse lasers, with femto- and picosecond pulse durations, has been investigated as a remedy for the formation of droplets.

The basic concept behind the application of ultra-short pulses is, that the energy deposition onto a target material is almost instantaneous. Nearly all of the energy absorbed by electrons in the target will be transferred to the lattice faster than the charasteristic time for heat transfer. Thus, the material is evaporated from a solid phase without significant heating of the target. As a consequence, results obtained in micromachining of different materials with pico- or femtosecond lasers have been excellent. Yet, the droplet- and debris-free evaporation does not quarantee the growth of particle-free films. Instead of large droplets the "cold ablation"-process produces a significant amount of nanoparticles.

We at ORC are currently developing a novel variation of the PLD, which is promising. We employ a high repetition rate of a fiber laser producing high-power picosecond pulses. The results with various materials indicate that we can deposit either films consisting of nanoparticles or dense, particle-free films (see Figs. 1 and 2).

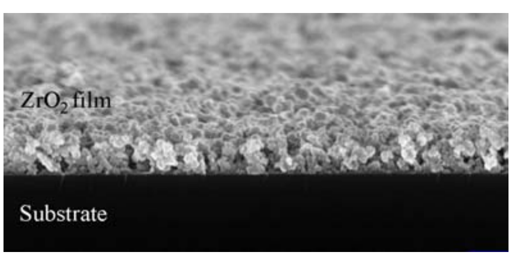

Figure 1 Deposited zirconium oxide , containing nanoparticles.

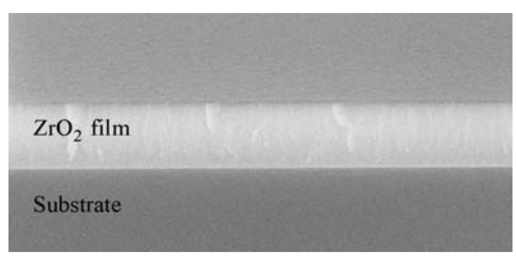

Figure 2 Deposited smooth zirconium oxide film.