temperatures measured by C. W. Carr et al at 1064 nm, 3 ns in several optical materials of different band gaps (see Fig. 7) [22]. The plasma temperature is dependent on the band gap of the material which can be attributed to the large energy needed to liberate an electron in a wider gap material. We observe at 1064 nm that the critical temperatures of simple materials and their mixtures well continue the trend of the plasma temperatures, this could indicate that the critical temperature in the studied mixtures may be related to the plasma temperature.

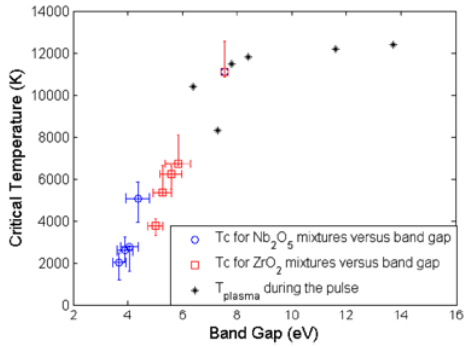

Fig. 7. Critical Temperatures extracted from fitting and Comparison with measured plasma temperatures from Ref [22].

5. Conclusions

Both ZrO_2/SiO_2 and Nb_2O_5/SiO_2 mixtures as well as the simple oxide material coatings were prepared and characterized in terms of damage behavior. The results of the nanosecond LIDT have been reported as a function of the mixture composition and the band gap. The LIDT decreases in both sets of the mixtures with the volumetric fraction of high index material. We find that the nanosecond LIDT of the mixtures is related to the band gap of the material as it has been widely observed in the subpicosecond regime. The damage probability curves have been fitted firstly by a statistical model where the precursor density is proposed to follow a power law versus fluence. Then they were studied by a thermal model based on the photo-induced thermal effect. The thermal model permits to relate the damage probability with the physical properties of mixture and initiating defects. Analysis of RBS has shown an incomplete oxidation of the materials which indicates that metallic or off-stoichiometric oxide defects are candidates as precursors. The influence of these defect types in different mixtures was discussed. We found that only metallic defects with high absorption can explain experimental results. A type of metallic defect with a complex index of 0.3 + 6•i and a maximum radius of 18 nm offered a good interpretation to the performance of damage probability for the whole set of samples. Damage precursor density was estimated by both models, the results show a good agreement between the two models. In addition, a density range up to 10^7 /cm^2 was comparable to the recent reported results for fused silica surface at high fluences. The critical temperatures of both simple materials and mixtures were estimated and thus band gap dependence was obtained. A good agreement was observed with the evolution of plasma temperatures from the literature, this could indicate that the critical temperature in the studied mixtures may be related to the plasma temperature.

Acknowledgments

We acknowledge financial support from Lithuanian Agency for Science, Innovation and Technology grant EIGULYS (Project Nr.31V-140) as well as the Lithuanian French Program Gilibert (the Lithuanian Science Council and the French Foreign Ministry).

#173024 - $15.00 USD Received 20 Jul 2012; revised 24 Aug 2012; accepted 28 Aug 2012; published 2 Nov 2012