

# Titanium Sapphire: A Decade of Diode-laser Pumping

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For many years, Ti:sapphire was the prototypical example of a solid-state laser material that could not be diode pumped. The rationale for this assessment follows from the laser properties of Ti:sapphire, which combine to demand high brightness pumping in the blue-green region (see fig. 1 [1]). The development of efficient Gallium Nitride (GaN) based laser diodes eroded this logic [2], and improvements in the spatial brightness of GaN diode lasers subsequently enabled the first demonstration of a directly diode-laser pumped Ti:sapphire laser in 2009 [3]. This presentation will outline the physics that makes diode-pumping difficult, and the developments that mean, it is, nonetheless, possible. Interestingly, diode-pumping of CW and modelocked Ti:sapphire lasers was achieved not by a radical redesign of the laser, but by careful optimisation of existing approaches that enabled the rapidly improving brightness of GaN diode lasers to be exploited [3-5].

The performance of these early systems was modest. In part, this was because the performance of GaN diodes was still marginal for Ti:sapphire pumping. However, this early work hinted at a second issue – that of pump induced loss for blue, rather than green pumping [3]. Rigorous subsequent work by Sawada et al. [6] and Moulton et al. [7] has begun to unpick the physics behind this effect. However, probably the most significant factor in the subsequent improvements in the performance and functionality of diode-pumped Ti:sapphire lasers has been the emergence of higher power and longer wavelength GaN diode lasers. These diodes have been harnessed by a number of groups world-wide to enable ground-breaking demonstrations. Particular highlights include the demonstration of Kerr-lens modelocking [8], of a frequency comb [9], of a regenerative amplifier [10], of broad tuneability [11], and the announcement of a first commercial system [12]. This progress indicates a bright future for diode-pumped Ti:sapphire lasers.

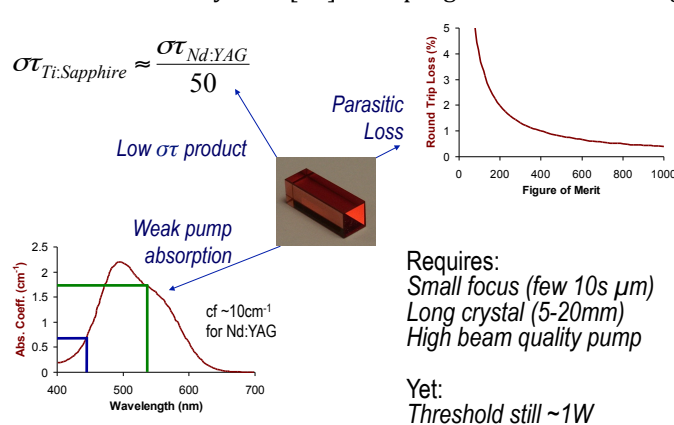


Fig. 1: Challenges for pumping Ti:sapphire (1cm, 0.1wt% crystal assumed)

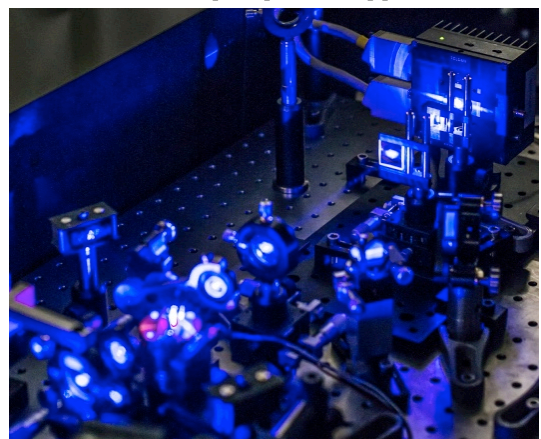


Fig. 2 : A diode-pumped Ti:sapphire laser

## References

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**30 word summary**

This presentation will review the challenges associated with diode-pumping of Ti:sapphire and the rapid recent progress made internationally in delivering diode-pumped Ti:sapphire lasers of increasing utility.