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Intracavity doubling of CW Ti:Sapphire laser to 392.5 nm using BiBO-crystal

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BiBO is a relative new crystal material, exhibiting on-linear coefficient higher than other crystals suitable for UV-generation (BBO, LBO) [1,2]. It shows high transparency down to about 285 nm, thus making it utilisable for frequency doubling of lasers with the resulting wavelength being in the UV region. In addition, BiBO is not hygroscopic, and thus doing away with the need for protective housing. In this work we present results obtained for intra-cavity frequency-doubling of a 785 nm CW Ti:Sapphire laser utilising BiBO as the non-linear crystal. Intracavity doubling offers several advantages compared to extra-cavity doubling, such as no need to couple to an external resonance cavity, and no need to make the laser pulsed to obtain reasonable efficiency, To our knowledge BiBO has not previously been utilised for CW intracavity doubling at 785 nm. At this wavelenght BiBO has a non-linear coefficient of 2.6 pm/V according to the supplier (FOCtek). The crystal is cut for type I phase matching, with a phase matching temperature of 23 degrees C. Cut angles were calculated to theta=149.9 degrees, phi = 90.0 degrees, see fig. 2. The lay-out of the Ti:Sapphire laser with the non-linear crystal inserted is shown in fig. 1. The laser is made as a W-cavity type with two beamwaists, waist at the laser crystal 60x65 microns, waist in the BiBO crystal 90x95 microns. Mirror curvatures are 150 mm for the mirrors 3 and 4, 100 mm for mirrors 1 and 2. Mirror 5 is plane. A single plate birefringent filter provides wavelenght tunability. The Pump source used is a Coherent Verdi V-5. The pump beam enters through mirror 1. The Ti:Sapphire crystal is 10 mm long, Brewster cut, doped 0.15% (FOCtek). Mirrors 3 and 4 have high-transmission coatings for 392.5 nm. Without doubler crystal inserted, and with 5% outcoupling mirror at mirror 5 position, the laser can give up to 600 mW at 785 nm. With the BiBO-crystal inserted, we observe two regimes. For low pump powers the blue output power follows the square of the pump power, see curve in fig. 3. When pump power exceeds 4.5 watts, the blue output becomes slightly fluctuating in power, and the output mode becomes slightly flickering at the edges – may be due to photorefractive effects[2]. The measured IR leak was only partially correlated with fluctuations in blue output. Maximum blue output at 5W green pump was measured to 6 mW, 3 mw in each direction. Though this is not a record for converson efficiency, these results were obtained with a very large beamwaists in the non-linear crystal. Work are in progress of testing laser cavity designs with beamwaist in the non-linear crystal in order of 50x50 microns. We believe this will give up to 10 times higher blue output . Also, using longer BiBO crystals should result in incresed blue output.

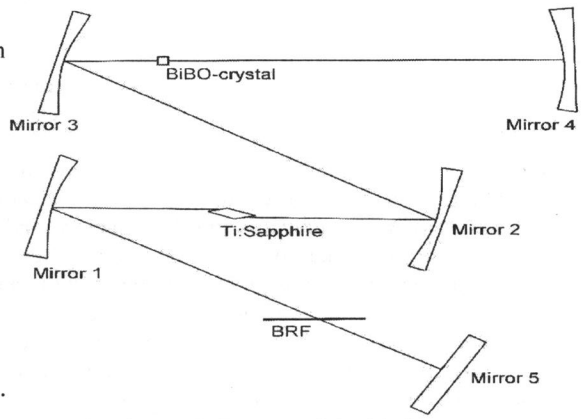

Figure 1: Lay-out of doubled laser.

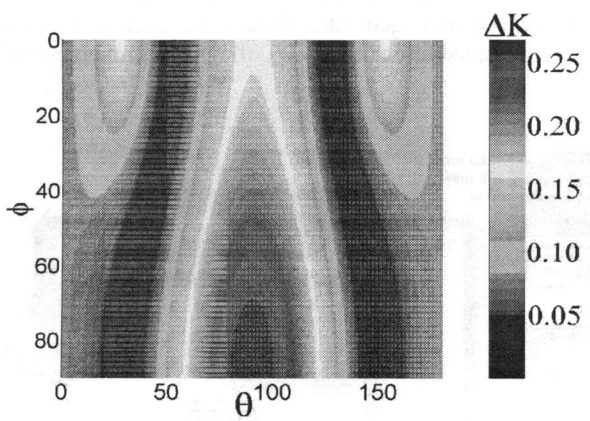

Figure 2: Phase matching diagram for BiBO crystal for type I phase matching.

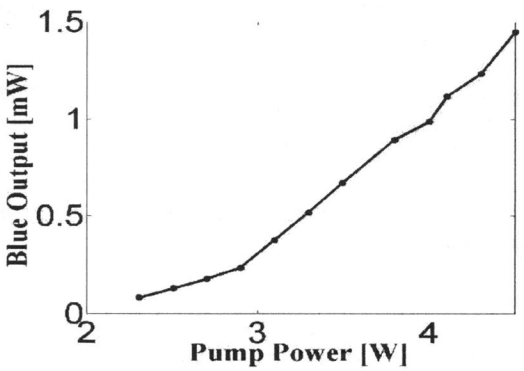

Figure 3: Output in blue

[1]H.Hellwig, J.Liebertz, L.Bohaty; "Linear optical properties of the monoclinic bismuth borate BiB3O6"; J. Appl. Phys.; Vol. 88, pp. 240-244; 2000

[2]V.Ruseva, J.Hald; "Generation of UV light by frequency doubling in BIBO"; Op. Comm.; Vol. 236, pp. 219-223; 2004