Comparison of A grown vs C grown Yttrium Vanadate

There has been a debate over crystal color and material quality for Nd:YVO_4 material since the material starting being used in the early 1990's. Material with a "cobalt blue" coloration was thought to be the best. Material is frequently seen in users labs and manufacturing floors with a greenish tint. It seems to perform acceptably but why the color difference? Our clients are beginning to see how the crystals are grown may make major differences in material quality and application performance. They have concerns about the warranty and the cost for replacement could be prohibitive.

Nd:YVO_4 is a uniaxial crystal with 1 C-axis and 2 A-axis. The critical time during growth of the boule is the annealing period. During crystal growth, the oxygen molecules will continuously escape to form YVO_3 phase in the boule. These oxygen molecules have to be replaced in an oxygen atmosphere during annealing. Experiments show the diffusion of oxygen molecules is much faster for crystals grown in the a-axis direction than that grown in the c-axis direction. Thus there will be less oxygen defects in the boule. The oxygen unfortunately will facilitate more iridium particles from the crucible to be oxidized and get into the crystal boule as defects. But without replacing the oxygen molecules, the boule will become oxygen deficient that also has detrimental effects on the bulk quality. Besides this problem, crystal dislocations, stress, multi-domains, micro-cracks and other defects are related to the properties of the thermal conductivity and the thermal expansion coefficients of the crystal. Since C-axis has a larger thermal conductivity and expansion coefficients than a-axis, this will induce more of these kinds of defects when Nd:YVO_4 crystals are c-grown than a-grown. These defects will ultimately produce larger absorption and thus larger loss in the crystals. Sky-blue color of the boules is a good qualitative measure of the crystal quality. Crystals that contains the above defects will appear green because of the different absorption spectra *(see Vanadate Crystals Exploit Diode-Pump Technology, DeShazer, February 1994 Laser Focus World).*

ITI is the only crystal manufacturer that provides A-grown Nd:YVO_4. Crystal growth experts have known that A-grown crystals yield higher quality crystal than of C-grown Nd:YVO_4 crystal because of the less oxygen defects and inclusions from the above phenomenon. But technical difficulties make it hard to grow A-grown Nd:YVO_4. ITI's own crystal growth experts have overcome this problem with a unique design of the furnace and growth procedure since eight years ago. The design of our furnace, which is based upon more advanced technology, has also enhanced us with a better and consistent optical quality of the vanadate. This improved quality of the material will directly impact on the performance of your laser systems.