

[17:46] <Doos> shall we do a little band gap theory?  
[17:47] <Frank> yes pleasee....I've got notes on it now...funny I never heard about it before  
[17:47] <Doos> is that explained in the course?  
[17:48] <Frank> yes but judging by the other theories we have covered (Valency transfers, hole centres etc) You explain better than the course notes do  
[17:49] <Frank> In fact the course notes would make heavy reading if we hadn't covered most of it already  
[17:49] <Doos> oh ok, the band gap theory is a little more abstract .. I don't pretend to know all about it  
[17:49] <Doos> the band gap theory applies to metals and diamonds  
[17:50] <Doos> there are basically 3 groups, conductors, semi-conductors and doped semi-conductors  
[17:50] <Doos> metals are in the first group  
[17:51] <Doos> the band gap theory gets its name from the fact that there is a gap between the groundstates and the higher energy levels  
[17:51] <Doos> in a metal all electrons move freely throughout the metal  
[17:52] <Doos> making them good conductors  
[17:53] <Doos> all the electrons fill the lower energy levels at will and reside there  
[17:53] <Doos> above the lower energy levels is a gap where none of the electrons can reside (I believe)  
[17:54] <Doos> above the gap are the higher energy levels where they can reside  
[17:54] <Frank> The course calls it the forbidden zone  
[17:54] <Doos> if the gap is small, then little energy is required for an electron to get elevated to the higher levels  
[17:54] <Doos> good name  
[17:55] <Doos> so only energy from light that is larger than the gap can be absorbed  
[17:56] <Doos> red light has 1.6 eV and blue has 3.1 eV (from the top of my head)  
[17:56] <Doos> so if the gap corresponds with 1.5 eV .. all visible light can be absorbed  
[17:57] <Frank> an opaque material??  
[17:57] <Doos> if the forbidden zone is large .. let's say 5eV .. no visible light can be absorbed  
[17:57] <Doos> yes, when it can absorb the light .. it will be opaque  
[17:57] <Doos> that is why the metals are all opaque .. small gap  
[17:58] <Doos> diamond has a very large gap, so is transparent  
[17:58] <Frank> k ty  
[17:58] Frank (~Guest@172.204.78.233) left irc: Read error: Connection reset by peer  
[17:59] Frank (~Frank@172.204.78.233) joined #go.  
[17:59] <Frank> am I back yet?  
[17:59] <Doos> no  
[17:59] <Doos> lol  
[17:59] <Frank> good  
[17:59] <Frank> :)  
[18:00] <Doos> the next bit I'm a bit uncertain about, but i think it works this way  
[18:00] Mari (~MariCinna@172.129.0.118) joined #go.  
[18:01] <Mari> Ok, I'm back  
[18:01] <Doos> because metals have a small gap .. an electron can get elevated to a higher energy level, so an electron (or more) is missing from the lower levels

[18:01] <Frank> hi Mari  
[18:01] <Doos> thus the electrons have even more space to move .. making them great conductors  
[18:01] <Doos> hi again Mari  
[18:01] <Doos> does that sound good?  
[18:02] <Mari> Sounds fine, but kinda murky  
[18:03] <Frank> yes I think so this is a small band gap we are talking about still?  
[18:03] Sara (~Guest@172.163.83.225) left irc: Ping Timeout  
[18:03] <Doos> diamond has a band gap of 5.5eV .. so not so many electrons will occupy the higher levels .. making them sem-conductors  
[18:03] <Doos> yes, metals are small gap  
[18:03] <Doos> or small forbidden zone  
[18:03] <Frank> yes  
[18:03] <Doos> diamonds are large gap materials  
[18:04] <Frank> and diamonds have larger forbidden zones?  
[18:04] <Doos> yes  
[18:04] <Doos> large gap = large forbidden zone  
[18:04] <Frank> this is the bit I'm not sure of  
[18:04] <Doos> gap = forbidden zone (two words for the same)  
[18:05] <Doos> what is that?  
[18:05] <Frank> yes  
[18:05] <Doos> what are you not certain about?  
[18:05] <Frank> how can the electrons make the jump accross the zone?  
[18:06] <Doos> ets say the gap corresponds to 3eV  
[18:06] <Doos> lets  
[18:06] <Doos> that means that you need more than 3eV applied to the electron to make the jump  
[18:06] <Frank> ok  
[18:06] <Frank> yes  
[18:07] <Doos> blue light carries 3.1eV, so blue light can be absorbed  
[18:07] <Doos> red light carries 1.6eV, so that is not enough energy to make an electron jump the gap  
[18:08] <Doos> so no red light can be absorbed  
[18:08] <Doos> like is a gap between 2 walls is 3 meter  
[18:08] <Frank> is it absorbtion...or enough energy to make an electron jump up a level?  
[18:08] <Doos> both are the same  
[18:09] <Frank> It's confusing calling Nm and Ev different things though I understand it's just a way of looking at it  
[18:09] <Frank> energy instead of length  
[18:09] <Doos> the longer the wavelength, the lower the eV  
[18:09] <Doos>  $eV = 1240 / \text{wavelength}$   
[18:10] <Doos> lets say two building are 3 meter apart  
[18:10] <Frank> where does the 1240 constant come from?  
[18:10] <Doos> if I have anough energy (equivalent to 3.1 meter) I can jump to the other side  
[18:11] <Frank> yes  
[18:11] <Doos> dunno, someone calculated that for us  
[18:11] <Frank> okay  
[18:11] <Doos> but if I'm not feeling well, I have little energy in me and cant make the jump  
[18:11] <Frank> ok  
[18:11] <Doos> so I'm not even going to try  
[18:12] <Frank> so you remain literally off colour (transparent) that day

[18:12] <Doos> so conductors (like metals) have a small gap  
[18:12] <Doos> yes  
[18:12] <Doos> lol  
[18:12] <Doos> semi-conductors (like diamonds) have a large gap (or forbidden zone)  
[18:13] <Doos> is that clear?  
[18:13] <Frank> yes  
[18:13] <Doos> ok  
[18:13] <Doos> then there are also doped semi-conductors  
[18:13] <Doos> doped really means that there is an impurity brought in  
[18:14] <Frank> natural or man made?  
[18:14] <Doos> both  
[18:14] <Mari> doesn't matter  
[18:14] <Frank> ok  
[18:14] <Doos> in the case of diamonds, there are a few possibilities .. boron and nitrogen  
[18:14] <Mari> boron makes for a positive type semiconductor, what about nitrogen?  
[18:15] <Doos> n-type  
[18:15] <Doos> if a boron atom replaces a carbon atom .. one electron is missing  
[18:16] <Doos> because boron has one electron less than carbon  
[18:17] <Doos> in effect this lowers the energy levels, making it a good conductor  
[18:17] <Doos> and it will absorb light better .. this results in a blue colour  
[18:18] <Doos> this is named a type IIb diamond  
[18:18] <Doos> nitrogen has one extra electron .. one more than carbon  
[18:18] <Doos> this makes for a poor conductor type Ib diamond  
[18:19] <Frank> So the boron borrows an electron from the diamond (Is this a valencey bond?) this lowers the energy level (of the diamond)  
[18:19] <Frank> this results in a blue colour?  
[18:19] <Doos> and will be yellow in colour  
[18:19] <Doos> the electrons move freely like in metals  
[18:19] <Doos> electrons  
[18:20] <Frank> so the electron transfer in both cases is conduction and not valence  
[18:20] <Doos> not one electron is assigned to one nucleus  
[18:20] <Doos> yes  
[18:20] <Frank> and the boron takes an electron while the nitrogen gives an electron  
[18:21] <Mari> it doesn't take, really  
[18:21] <Doos> it doesn't take  
[18:21] <Doos> lol  
[18:21] <Mari> carbon has four bonds, boron has three  
[18:21] <Doos> it's an empty space  
[18:21] <Doos> have you been secretly reading Mari?  
[18:21] <Mari> Yes  
[18:21] <Frank> who is Mari?  
[18:21] <Mari> I'm Sara  
[18:21] <Doos> sara  
[18:22] <Frank> Sorry Mari I'm not sure we've been introduced  
[18:22] <Mari> lol  
[18:22] <Frank> Ah Sara  
[18:22] <Frank> Mati Hari of gemmology  
[18:22] <Mari> Sorry for confusing you  
[18:22] <Frank> sokay

[18:23] <Frank> where did you read up on it?  
[18:23] <Mari> Apollo diamond and Gemesis diamonds, respectively  
[18:23] <Doos> on their websites?  
[18:23] <Mari> Nah, I read a few articles some time back  
[18:24] <Doos> on the internet?  
[18:24] <Mari> gemesis with nitrogen, apollo with boron  
[18:24] <Mari> yes  
[18:24] <Doos> give us the links then woman!  
[18:24] <Frank> lol  
[18:25] <Mari> Anyway, boron is three of four bonds and why the electron is free  
[18:25] <Mari> it's like a hole  
[18:25] <Mari> I'll dig them up  
[18:26] <Frank> dig the holes?  
[18:26] <Mari> No, the urls for the sites  
[18:26] <Doos> because there is a hole/empty space .. the electrons have more room to travel  
[18:26] <Frank> :)  
[18:28] <Doos> so that really is all I have to report on the band gap theory  
[18:29] <Frank> This can work for all semi conductors?  
[18:29] <Frank> quartz?  
[18:30] <Doos> I'm not sure .. I believe it does for corundum (band gap + molecular orbitals)  
[18:30] <Mari> I'm still confused on the difference of single crystal growth v. polycrystalline growth and how they differ as conductors  
[18:31] <Frank> single crystals have evenly aligned structure and atom alignment  
[18:32] <Frank> twins or poly's have sharp corners in them with electron travel between more resistant  
[18:32] <Frank> I think  
[18:33] <Doos> dunno  
[18:33] <Doos> the clouds in which electrons travel are very complex  
[18:34] <Mari> nb  
[18:35] <Mari> That was the cat  
[18:35] <Frank> My new course notes speak about additional energy levels which appear from the diagram to exist in the forbidden zone  
[18:35] <Doos> the cat can type the abbreviation for nota bene?  
[18:35] <Mari> Yes  
[18:35] <Frank> nitrogen and Boron are both marked on the diagram between the valence level and conductance level  
[18:36] <Doos> yes Frank .. that is what happens in corundum aswell i believe  
[18:36] <Frank> ok  
[18:36] <Doos> nitrogen acts as a donor and boron as an acceptor  
[18:37] <Doos> I'll see what my notes say about it .. dont believe it was in the notes when i studied  
[18:38] <Frank> I can scan you the notes if you'd like them  
[18:38] <Doos> that would be great (if it isnt too much work)  
[18:39] <Mari> How did your exams go, Frank?  
[18:39] <Frank> I'll do em through the week  
[18:39] <Frank> went well Mari  
[18:40] <Mari> Good to hear  
[18:40] <Frank> :)  
[18:40] <Frank> yes  
[18:40] <Mari> I am going to start this fall  
[18:40] <Doos> ah nice  
[18:40] <Frank> ggod plan  
[18:40] <Frank> good\*

[18:42] <Frank> Is that the lesson for the week?

[18:42] <Doos> yes I think so