

# Epiportal User Instructions

## Introduction.

This is a step by step guide in how to create a growth request using the EPSRC National Epitaxy Facility (NEF) Epiportal. The Epiportal allows the customer to log in and build a growth structure, layer by layer to the specifications required. Resulting in improved communication with the customer, and also consistent record keeping of wafers grown and supplied by the NEF.

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## 1. The Epiportal

The Principle Investigator (PI), who holds a current EPSRC grant with the NEF, will be given an account to access the epiportal, where they can oversee all growth requests made against their grant or any other grants that they may hold. Additionally, if the PI requests it we can also add accounts for RAs and students to the grant, so that they can also make requests via the epiportal. Access for RAs and students will only be given with the authority of the PI of the grant. To arrange this contact R. Airey, giving the name of the RA/student, their email address and which grant they can access.

**NOTE: ALL GRANTS AND USER ACCESS DETAILS ARE TREATED AS CONFIDENTIAL BY THE NEF.**

### 1.1. Logging in

Enter your username and password provided by the NEF. Any problems logging in, contact: Rob Airey ([r.airey@sheffield.ac.uk](mailto:r.airey@sheffield.ac.uk)).

Once logged on, you will be presented with either a screen with no growth requests against the grant (see figure 1 below). Or if you are an established user, all your current requests under your active grants will appear on the screen, as shown in figure 2.

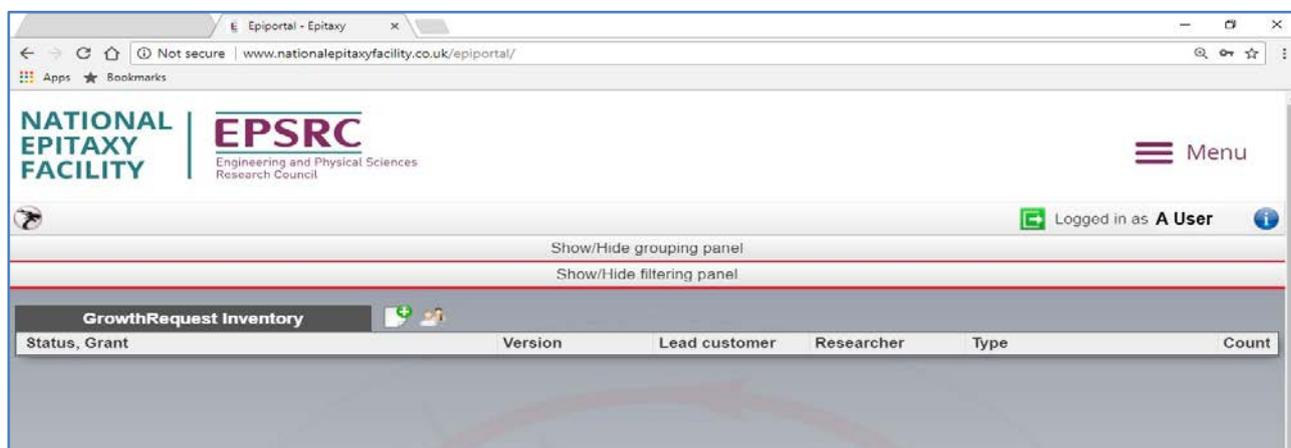


Figure 1 - View of home screen for a grant with no requests made on it.

Grant, Status	Researcher	Request type	Count
Grant2-example			1
New			1
#321 (2016-04-12 11:00)	A N Other	EPSRC	
Grant1-example			2
New			2
#307 (2016-04-09 09:50:0)	A N Other	EPSRC	
#308 (2016-04-09 10:30:0)	A N Other	EPSRC	

Figure 2 – View of home screen for an established User with grant requests in place and their status.

## 2. Navigating the Home screen

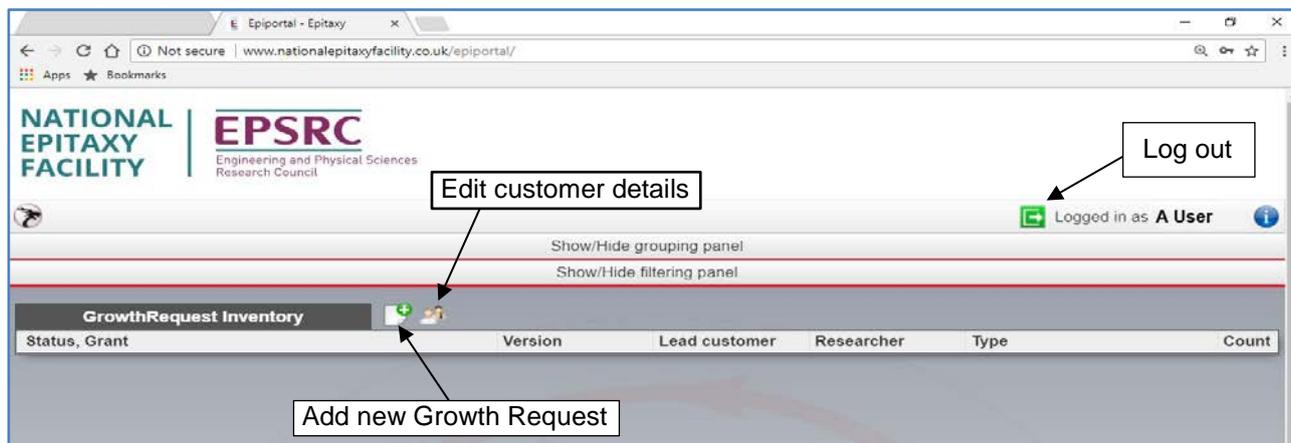


Figure 3 – Features on the epiportal home page

### 2.1. Home screen icons

Figure 3 above shows the features available on the epiportal home page:

- The “**Log out**” icon which is self-explanatory.
- Clicking on the “**Edit customer details**” icon, opens up the window shown in Figure 4 below, allowing a User to change their log in password and telephone number if desired. **Note: passwords must be at least 6 characters long and must contain characters out of 3 categories, from the 4 that are available, e.g. lower case, upper case, integer, punctuation and character – otherwise the system will not change the password.**
- The “**Add new Growth Request**” icon starts the process of making a growth request and will be discussed in detail in section 3.
- Two other features that are also on the epiportal home page are the: “**Show/Hide grouping panel**” and the “**Show/hide filter panel**”. These are shown at the top of figure 3 and turn red in colour when the mouse cursor hovers over them.

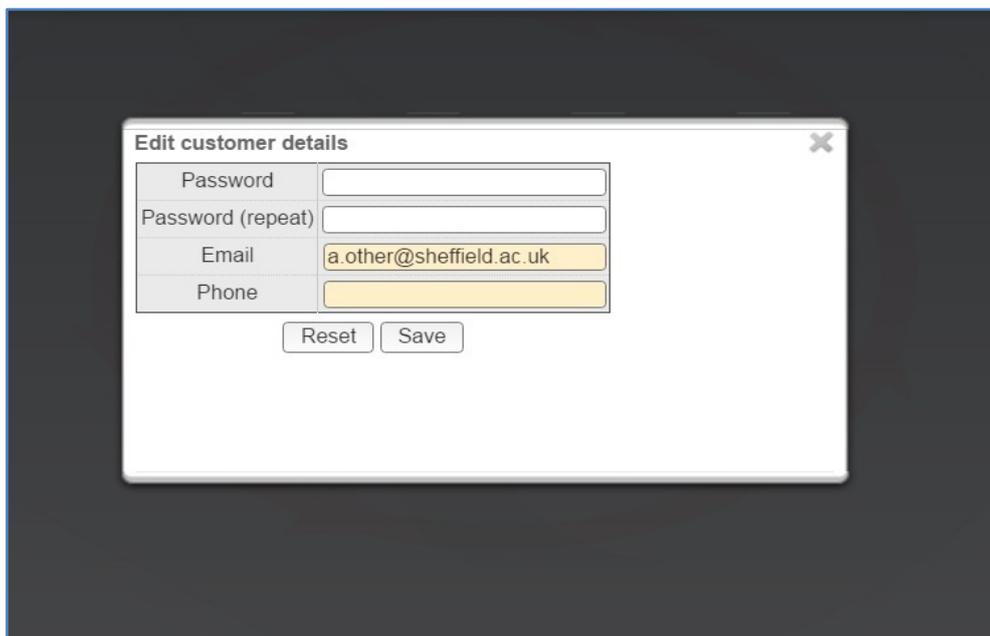


Figure 4 – Edit customer details window.

## 2.2. The Show/Hide grouping panel

Clicking on the “**Show/Hide grouping panel**” bar expands the home page, to show a series of display column options allowing the User to alter the layout of the home page to one that is more suitable.

What the various display options do, is given below:

- The Grouped columns (blue), controls what is seen in the tree file display on the left-hand side of the home page (see figure 5 below).
- The Displayed columns (gold), controls what is displayed in the centre of the home page (see figure 5 below).
- And as its name suggests the Hidden columns (red), holds what is not needed by the User in the home page display.
- And finally the count column on the far right of the home page, shows the number of requests associated with the grant and always remains visible.

As many of the display options can be placed in the columns as required. An example of how to change the display is given on the next page. Click on the “**Show/Hide grouping panel**” bar again to collapse the screen, hiding the display column settings from the home page.

**Note: Changing the layout of the home page does not affect any of the data entered into the epiportal.**

The screenshot shows the Epiportal interface. At the top, there are logos for the National Epitaxy Facility and EPSRC, along with navigation links: HOME, ABOUT US, III-V TECHNOLOGIES, SILICON TECHNOLOGIES, NEWS/EVENTS, LINKS, CONTACT US. Below the logos is a 'Show/Hide grouping panel' bar. This panel is expanded, showing three columns: 'Grouped columns' (blue), 'Displayed columns' (gold), and 'Hidden columns' (red). A callout box points to the 'Show/Hide grouping panel' bar with the text 'Click on the panel bar to expand or collapse the settings'. Below the panel is a table titled 'GrowthRequest Inventory' with columns for Grant, Status, Version, Lead customer, Researcher, Request type, and Count. The table shows a tree view on the left and a data table on the right.

Grant, Status	Version	Lead customer	Researcher	Request type	Count
Grant2-example					1
New					1
#321 (2016-04-12 11:00)	1	Prof. X	A N Other	EPSRC	
Grant1-example					4
Definition					1
Delivered					1
New					2

Figure 5– Show/Hide grouping panel

### 2.3. An example of changing the display

In this example the display is changed so that the “Lead customer”, appears at the top of the request hierarchy, and the request “Version” is removed from the display altogether by:

1. Moving the “Lead customer”, by clicking and holding on the text and dragging it towards the Grouped columns section.
2. Move over the Grouped columns until a space appears.
3. Once it is over the desired position/correct order, release the mouse button and the text will drop into place, note how the display has changed.

**Note:** To expand file tree structure of the Grouped columns, click on the “+” at the base of the folder icons. Clicking on the “-“closes the folder again - see figure below.

- A. To move the “Version” option. As before click and hold on the text and drag it towards the Hidden columns section.
- B. Again a space will appear when the display option text is over the Hidden columns.
- C. When it is over the Hidden columns option, release the mouse button and the text will drop into place, note how the display has changed.

Drag and drop action

Expand, click on “+” the file tree structure. Click again to collapse it back.

Lead customer, Grant, Status	Researcher	Request type	Count
Prof. X			
Grant2-example			1
New			1
#321 (2016-04-12 11:00)	A N Other	EPSRC	
Grant1-example			4
Definition			1
#305 (2016-04-04 10:27.0)	A N Other	EPSRC	
Delivered			1
#254 (2016-02-11 16:05.0)	A N Other	EPSRC	
New			2
#307 (2016-04-09 09:50.0)	A N Other	EPSRC	
#308 (2016-04-09 10:30.0)	A N Other	EPSRC	

Figure 6 – Click and dragging the display options to form a new layout.

The display options can be moved around into different combinations as many times as required, until a desired layout is achieved. To retain a specific display layout as a default, get the display options into the desired arrangement in the manner described on page 5, and then click on the “**Save grouping to profile**” button (figure 7 below). If during an epiportal session the display is altered, the default can be quickly recovered by clicking on the “**Get grouping from profile**” button. The profile can also be removed via the “Delete Grouping profile” button (figure 7).

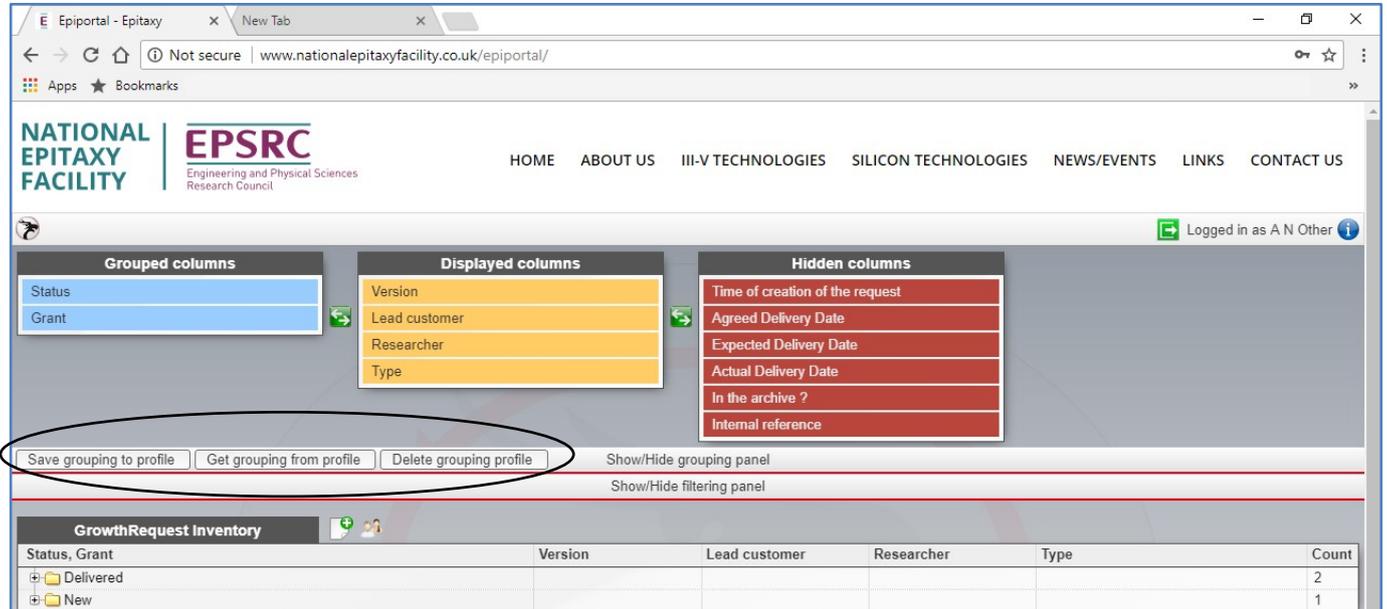


Figure 7 – Save, Get and Deleting grouping profile

#### 2.4. The Show/Hide filtering panel

Just like in the previous section, clicking on the “Show/Hide filtering panel” expands the home page to reveal the filter menu and settings, as shown in figure 8 below.

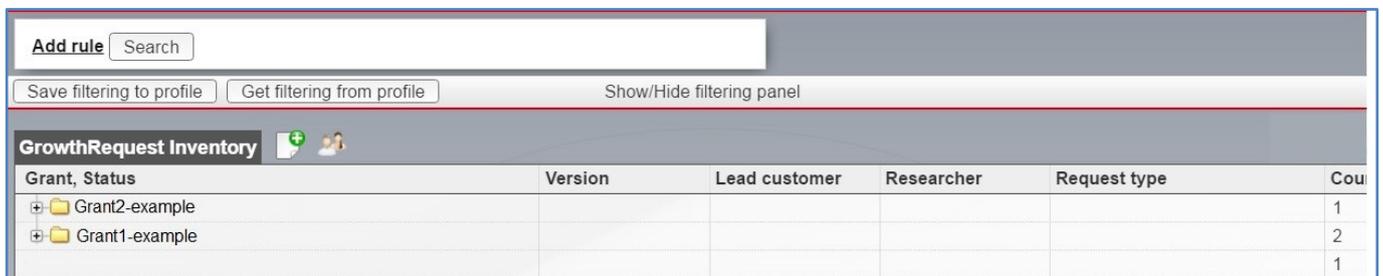


Figure 8 - Show/Hide filtering panel

#### 2.5. Filtering example 1.

In this example the User requests to see how many “New” requests they have on their active grants by doing the following actions:

- 2.5.1. Click on the “Add rule” text shown in figure 8 above. A drop down menu will appear, with a number of filtering options, figure 9.
- 2.5.2. Select “Status” from this drop down menu, figure 9. Once an option is selected another drop down menu appears on the right of the filtering system, as shown in figure 10 on the next page. **Note:** The central menu contains the logic operators: =, !=, <, <=, >, >=. The default setting is “=”, which is used in this example.

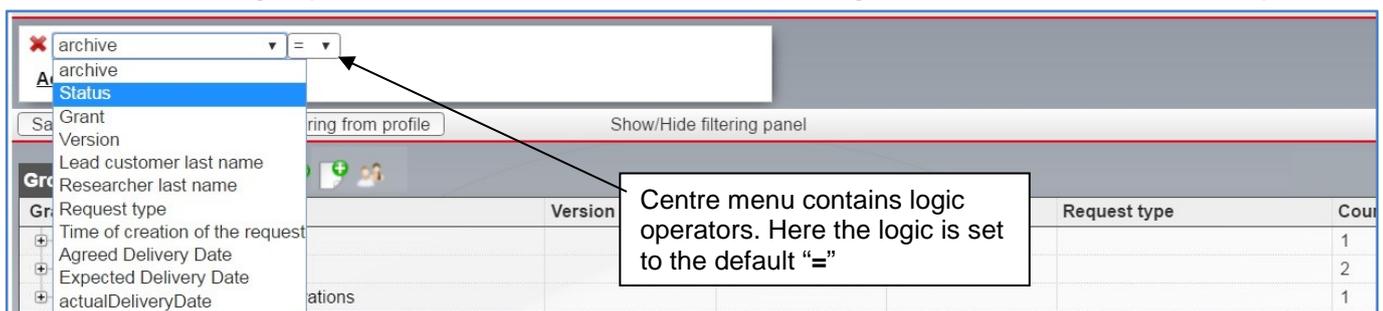


Figure 9 – Choosing the first filtering option

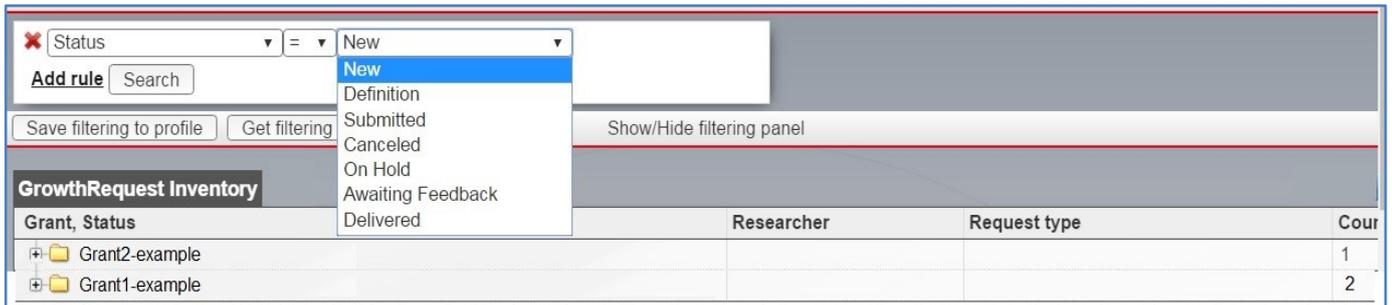


Figure 10 – Choosing the second filtering option

2.5.3. The User selects the filtering option “New”, as shown in figure 10 above.

2.5.4. Clicking on the “Search” button to activates the selected filter options. The display will change so that grants containing **ONLY** a “New” request will appear. Expanding the folders by clicking on the “+” at the left of the folder icons, reveals the grant name and the request details that have the status of “New”, as shown in figure 11 below. The User can then click on the requests to see further information, as detailed in section 3.



Figure 11 - Filter results showing “New” requests only

2.5.5. Remove the filter by clicking on the “X” icon. The home screen will then go back to the display settings the User has set up using the “Show/Hide grouping” display options, discussed in sections 2.2 and 2.3.

2.5.6. Clicking on the panel bar will collapse the screen so that the filter function disappears. Be aware, if the User closes the “Show/Hide filtering panel”, before removing the filter as described in step 2.5.5; the filter will remain active and will still affect the display. The User can quickly tell if the filter has been left on by looking at the status of the filtering panel. If the filter is on then the text in figure 12, highlighted in red, appears on the filter panel bar. The problem is easily remedied by simply clicking on the filter panel to open it up again and then clicking on the “X” icon to deactivate the filter.

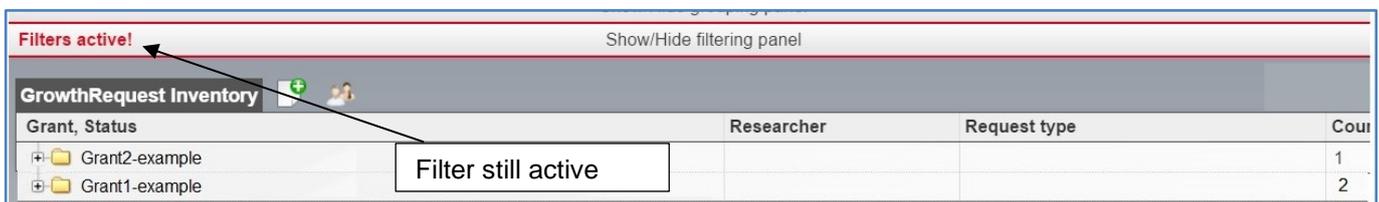


Figure 12 - Filter active

**Note: As in the case of the display options, the filtering panel has NO effect on the contents of the requests.**

## 2.6. Filtering example 2 - Multiple filters

Figure 13 shows an example of a multiple filter using the “Add rule” and “AND” logic functions. Here the “Time of creation of requests” filter is set to look for **NEW** requests within these limits: > 2016-04-01, 9am **AND** < 2016-04-20. 17:00. Any requests outside these limits is not displayed.

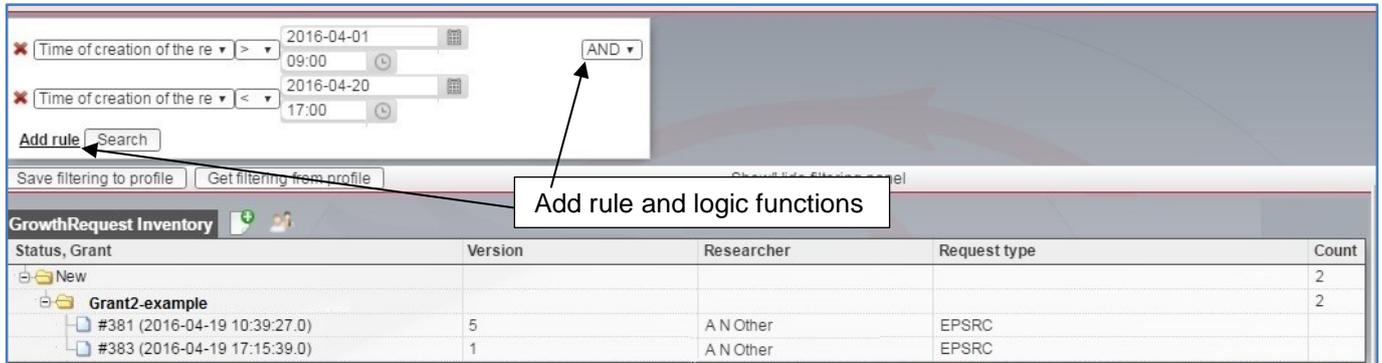


Figure 13 – Multiple filter example

## 3. Creating a growth request

There are two main steps in submitting a wafer growth request into the epiportal. The first step is the **growth request**, which contains details of the grant, the lead customer and researcher (someone other than the lead customer, e.g. research assistants or PhD students). The second step is the **growth structure**, containing the details of the epitaxial layers, e.g. materials, layer thicknesses and doping levels etc.

For an overview of the **growth request** and **growth structures** hierarchy, see Appendix A.

### 3.1. Step 1 – Placing the growth request.

The User starts the growth request process by:

- 3.1.1. Click on the “Add new Growth Request” icon in figure 14 (Note: it has been assumed that no other requests have been made). This opens the window shown further down the page, in figure 15.

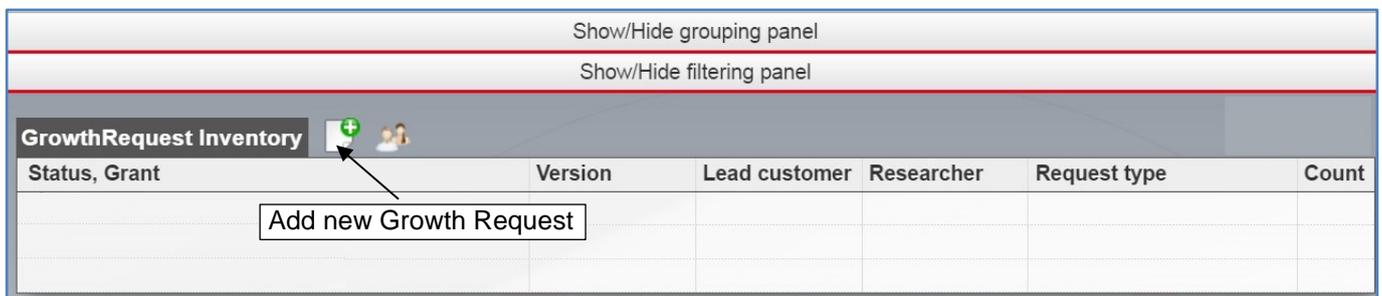


Figure 14 – Starting a growth request

- 3.1.2. Select the grant from the first drop down menu (the lead customer name and email address will be populated automatically). **Note: Only the grants that are assigned to the lead customer and his/her research team will be visible.** Select the appropriate Researcher from the next drop menu (figure 15). Finally click on “Save” to secure the information that has been entered. A **growth request** has now been saved to the epiportal.

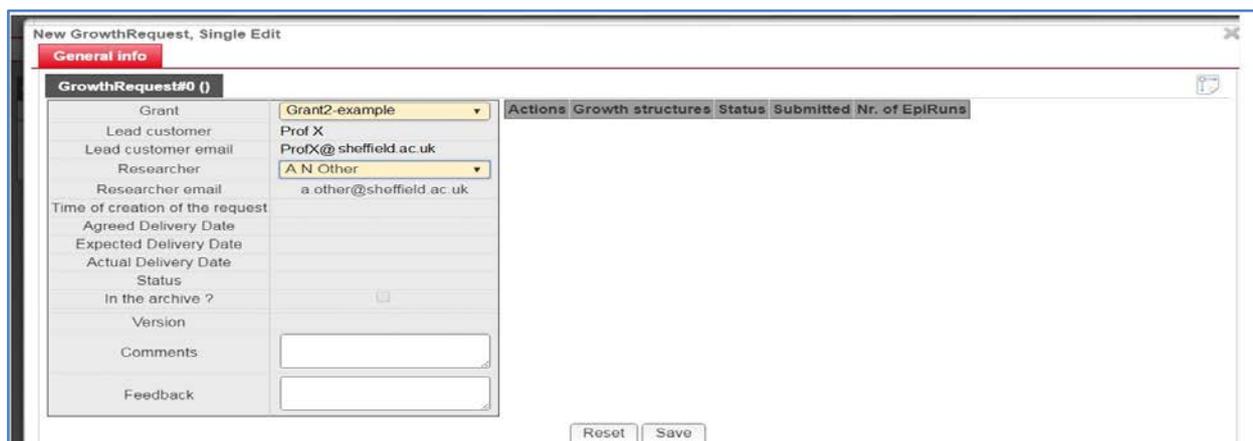


Figure 15 – Grant and customer information

### 3.2. Step 2 – Placing a growth structure.

3.2.1. Clicking the save button activates the **“New growth structure”** icon that appears in the Actions column on the left of the window (see figure 16). The save action also assigns a request number and the date that the request was created on.

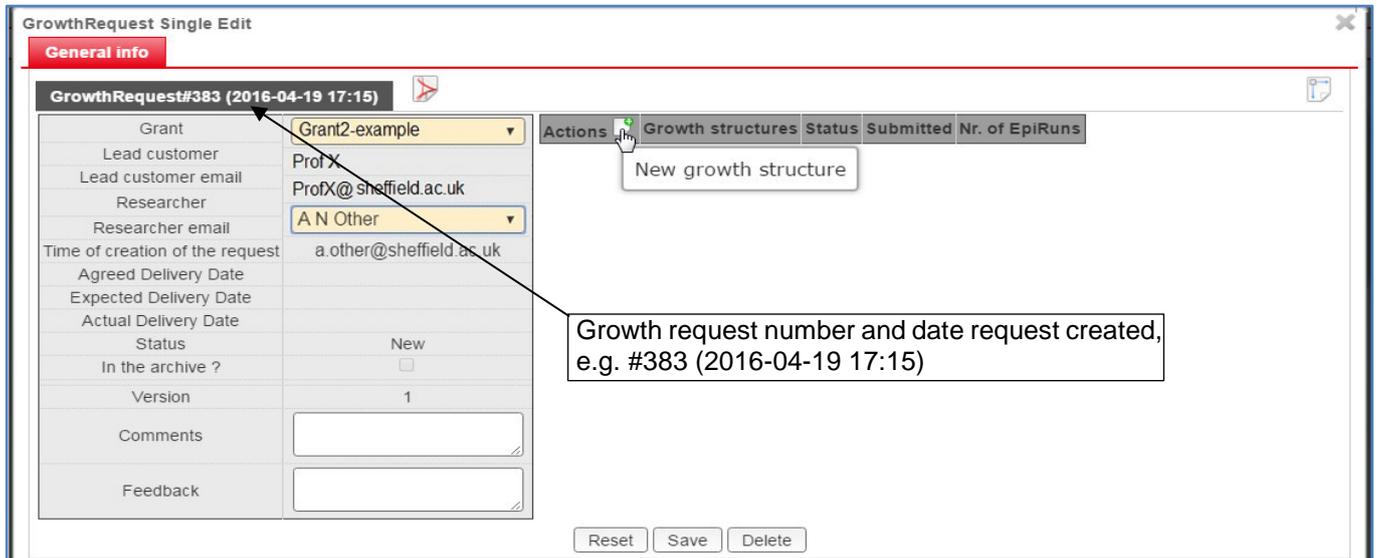


Figure 16 – Activation of the “New growth structure”

3.2.2. Clicking the **“New growth structure”** icon shown above, opens the window below (see figure 17). The column on the right hand-side contains the substrate information and also what epitaxial growth method is required. The growth method does not have to be selected if the User is not sure of the best technique; the NEF staff can advise and select the best growth method on the User’s behalf.

3.2.3. Simply choose from the pull down menus what substrate material, number of wafers and wafer sizes are required and click on save. **Note:** the fields that are greyed out are for NEF staff to complete.

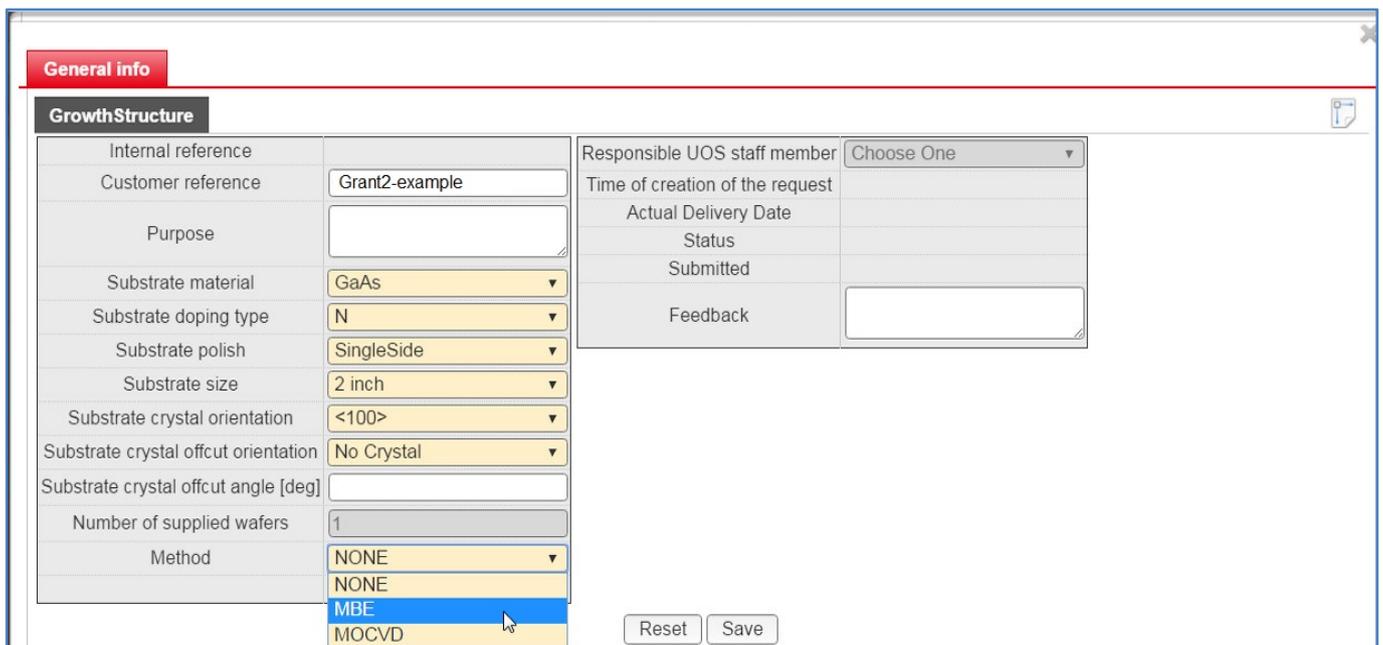


Figure 17 – Stating the substrate and growth type

When the substrate details have been saved, the window changes so that the **Characterization, Layers** and **Document** page labels appear as shown in figure 18. The **Finish** button that appears, should only be activated once the User has entered all their growth structure requirements and is satisfied that it is correct.

**Note: Clicking the Finish button moves the status of the request from “New”, to the status of “Definition” where IT CAN NO LONGER BE EDITED. To reduce accidental status changes the epiportal issues a confirmation message, asking the User to confirm if they want to go to “Definition” status (see appendix B for details).**

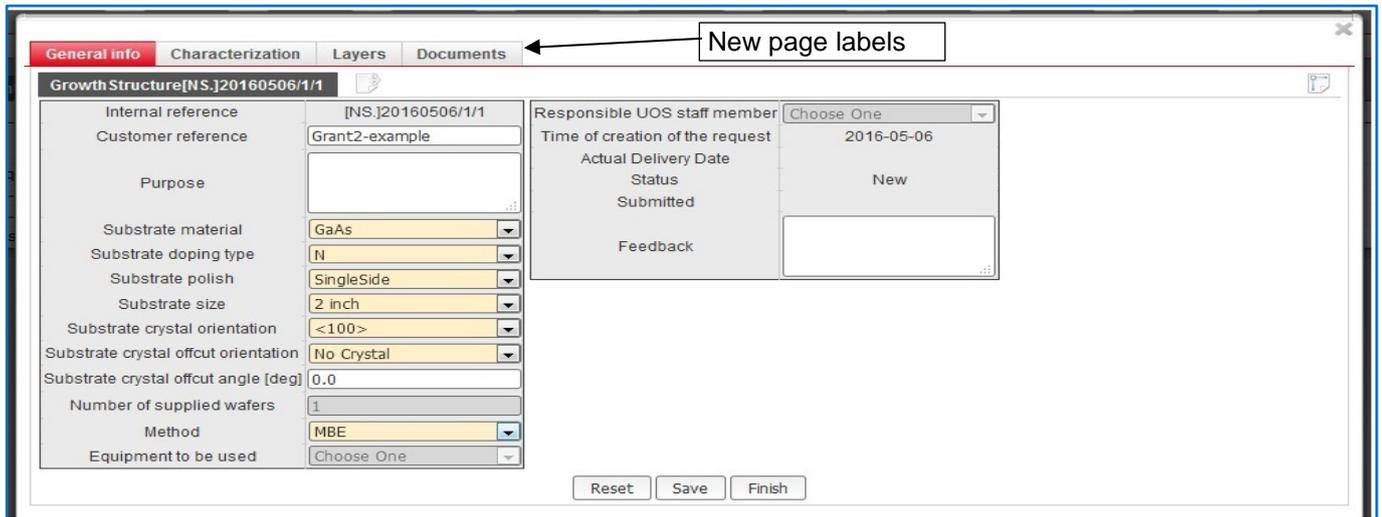


Figure 18 – Characterization, Layers and Document page labels.

3.2.4. Clicking on the Layers page label, opens the window shown in figure 19. In this figure the User can see the date of the creation of the growth structure ([NS.]20160506/1/1 – the NS indicating that the request has not been assigned a growth reactor – this is normally done by the NEF’s growth staff).

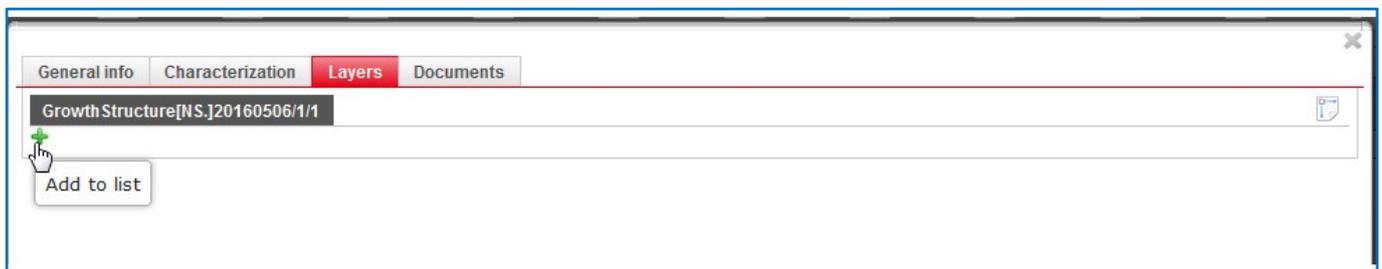


Figure 19 – Adding the first growth layer to the structure.

3.2.5. Clicking on the “+” icon (shown above), inserts the first layer to be grown on top of the substrate, into the structure. It also opens the layer editor dialogue box (figure 20), here the User can select the material, layer thickness, layer repeats and doping levels required.

**The section after figure 20 gives details of what each box means and what is required.**

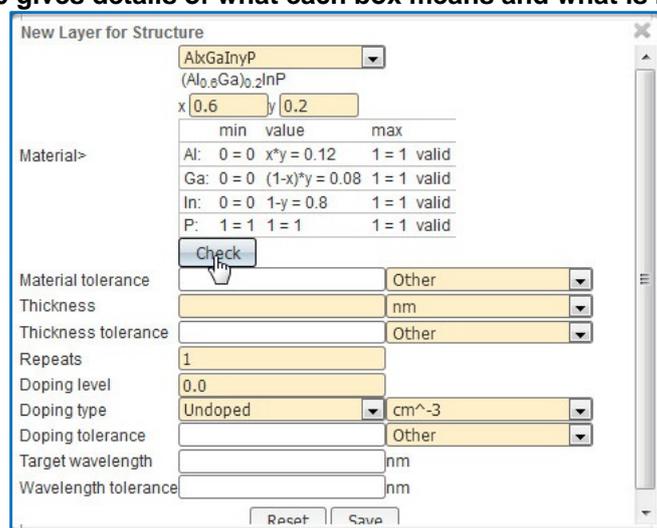


Figure 20 – Layer editor dialogue box

**Material:** select this from the drop down box. If a subscript (or multiples) is required you will get a box to add x (y and z...), the values of which will be between 0 and 1. Pressing the check button will check the indices are correct and display the material with the actual subscripts. If your material is not listed, or you wish to define it with different parentheses. Then User can select the **“User Defined”** option which generates a free text box immediately below, in which the User can enter their material requirements.

**Material Tolerance:** This field can be left blank, in which case the NEF will grow the layer on a best effort basis. However, if the composition tolerances in the structure are critical then this must be used in order to help the NEF meet the User’s requirements. Selecting the **“Other”** option in the material tolerance drop down menu is free text, so comments are accepted.

**Thickness:** Enter a thickness specifying the unit in  $\mu\text{m}$ , nm or  $\text{\AA}$  (defaults to nm). The values must be  $>0$ .

**Thickness Tolerance:** As with the material tolerance. But once again, if the thickness tolerances in the structure are critical then this must be completed.

**Repeats:** The number of times a stack of layers should be repeated (e.g. in a DBR). Changing the number of repeats will cause a split in the structure to give a repeat stack in the editor. Should you wish to have two repeats of the same repeat number sat on one another it is necessary to create a dummy layer between them to split them up (select dummy material). Repeats defaults to 1.

**Doping Level:** Specified in scientific notation (e.g.  $1\text{E}17$  is  $1 \times 10^{17}$ ). Leave as 0.0 for undoped or if you wish to specify a minimum doping level. This can be stated in the doping tolerance box as free text by selecting **“Other”** once again. The units default to  $\text{cm}^{-3}$ , but can be changed to  $\text{cm}^{-2}$  if you are specifying a sheet doping.

**Doping Tolerance:** Can be left blank, but as before if the doping tolerances in the structure are critical then this must be completed. As stated above, selecting **“Other”** the tolerance box becomes a text field.

**Target Wavelength:** If a specific emission wavelength is required then the User can enter the value in this field, or left blank if not required. The units are nm.

**Wavelength Tolerance:** Here the tolerance on the Target Wavelength is stated, e.g. 2nm or 5nm. The Target Wavelength and the Tolerance will then appear together in the layer structure in the form:  $500.0 \pm 2.0\text{nm}$  (see below).

Enter the details of the new layer in the pop-up menu and click save, to add the layer to the overall structure as shown in figure 21 below. Layers can be: added above and below other layers, deleted, edited individually and copied in groups by using the drag and drop facility. Figure 22, shows the different icons and their functions.

Thickness	Repeats	Material	Doping	Target wavelength and tolerance
100.0 nm	1	GaAs	$2.0\text{E}19 \text{ cm}^{-3} \text{ P}$	
30.0 nm	1	InAs	$0.0 \text{ cm}^{-3} \text{ Undoped}$	
80.0 $\text{\AA}$	3	$\text{In}_{0.6}\text{GaAs}_{0.2}\text{P}$	$0.0 \text{ cm}^{-3} \text{ Undoped}$	$1050.0 \pm 2.0\text{nm}$
50.0 nm	3	$(\text{Al}_{0.6}\text{Ga})_{0.2}\text{InP}$	$0.0 \text{ cm}^{-3} \text{ Undoped}$	
100.0 nm	1	GaAs	$2.2\text{E}18 \text{ cm}^{-3} \text{ N}$	
Substrate				

Figure 21 – Layer structure Layer editor dialogue box

Direction of Growth

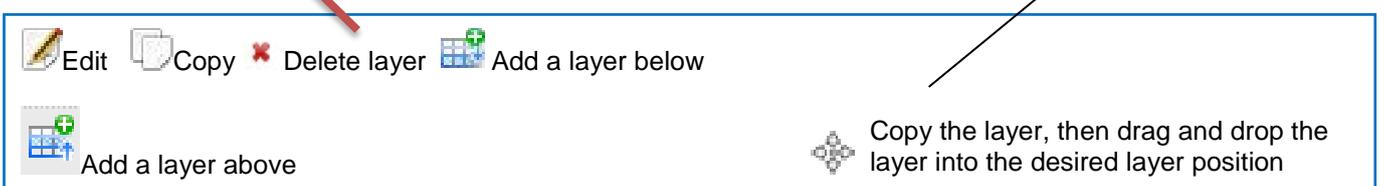


Figure 22 – Layer structure Layer editor dialogue box

### 3.3. I've finished the structure. What's next?

When the structure is complete, the User can click on either the **Characterization** option (see section 3.4), or select the **Documents** option (see section 3.5). The **Characterization** and **Documents** sections do not have to be completed, but they are there to provide the opportunity to supply any additional information to the NEF, in order to help meet the User's requirements. If satisfied there is enough information to carry out the growth then the User can either:

- i. Logout and the system will hold the request at that point.
- ii. Press the "**Finish**" button to finalize the growth structure. However, the User should only do this if they are completely satisfied it is correct and that the structure does not need to be copied within the current request (see item iv).
- iii. Make another growth request on a different grant (if the PI has more than one grant the NEF), by closing all the open windows to get back to the screen shown in figure 14. And then clicking on the "**Add new growth request**" symbol to start the process again as described in section 3.1.
- iv. Add a completely different growth structure by clicking on the "**New growth structure**" symbol (figure 16), and following the instructions (section 3.2). This new growth structure will be grown under the same grant as the structure just completed.
- v. Enter an additional growth structure very similar to the one just entered into the system. This can be easily achieved by using the "**copy structure**" function, which allows the User to duplicate the structure previously entered and then edit it. Details of how to do this can be found in section 3.6.
- vi. Copy the growth structures to a new growth request. Section 3.7 gives an example of how to do this.

### 3.4. Characterization options

Select the Characterization page label (figure 18), then click on the "**New characterization**" icon and the window shown in figure 23 appears. From the drop down menu select the characterization method to be performed and enter the reasons behind the measurements in the purpose section. The "purpose" field should be completed to let the NEF staff know what you wish to find out from the characterization, to ensure the data is supplied and interpreted accordingly. If the characterization option is left blank, quality assurance tests are still carried out as standard on the wafer to ensure customer satisfaction.

Figure 23 – Selecting the characterization requirements.

Saving the details, closes the window and the characterization requirements are then confirmed in the main characterization window (figure 24).

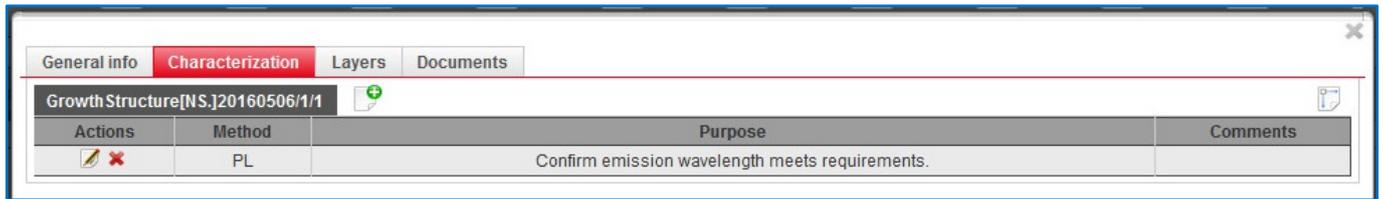


Figure 24 – Confirmation of characterization requirements.

### 3.5. Documents upload

If required, click on this option if you wish to upload additional information e.g. modelling results, device fabrication details etc.

### 3.6. Copying growth structures

As stated in point (iv) of section 3.3, the growth structures can be copied and edited, making the task of entering several similar growth structures into the epiportal, much quicker. This is done as follows:

3.6.1. Close the growth structure window and the User will see the growth request window behind it, showing details of the latest structure, e.g. request number and status, as shown in figure 25.

3.6.2. Click on the “Copy the growth structure” button

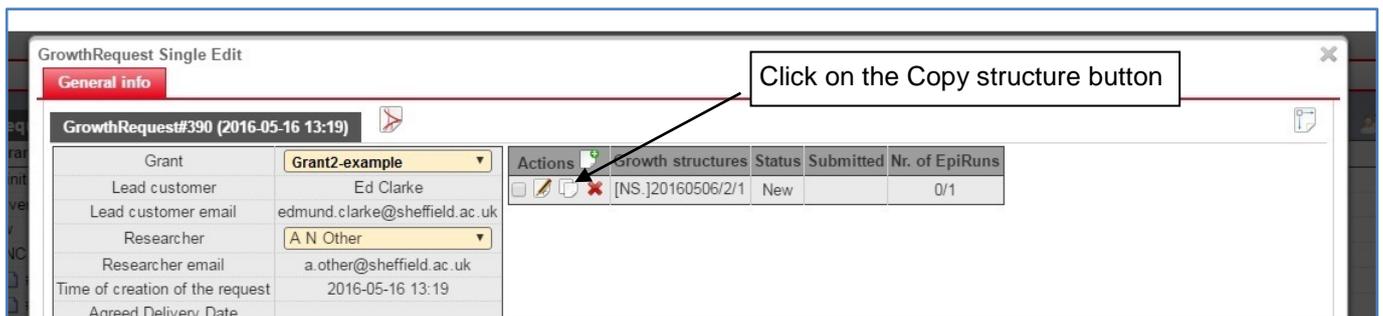


Figure 25 – Copying a growth structure in the same request.

3.6.3. When the button is clicked the growth structure copy will appear directly underneath the original structure (figure 26). Again this structure can be edited as described in section 3.2 to 3.5. The copying of a growth structure is now complete. Note: the growth reference numbers distinguish the structures at the growth request level.

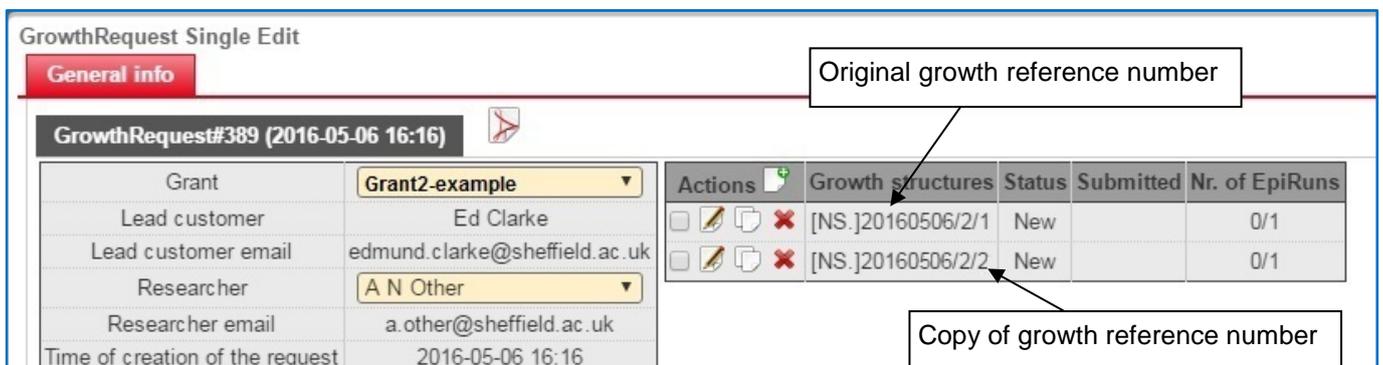


Figure 26 – A copied growth structure

### 3.7. Copying growth requests

Occasionally Users request repeat growths of an entire growth request (growth structures included within), that has been delivered and therefore can no longer be edited. In the past the only way to solve this was for the User to re-enter the old growth request, and the associated growth structures again from the start (which if there are a large number of differing growth structures inside it), can be quite a lengthy process. Fortunately in this upgrade of the Epiportal a “**Copy growth request**” function has been added to make this task very easy, and it is carried out as follows:

- 3.7.1. Open the growth request window of the request that needs to be copied (the old request), as shown in figure 27 below.
- 3.7.2. Click on the check box on the structure to be copied. Once this is done the “**Copy growth request**” icon appears (figure 27).

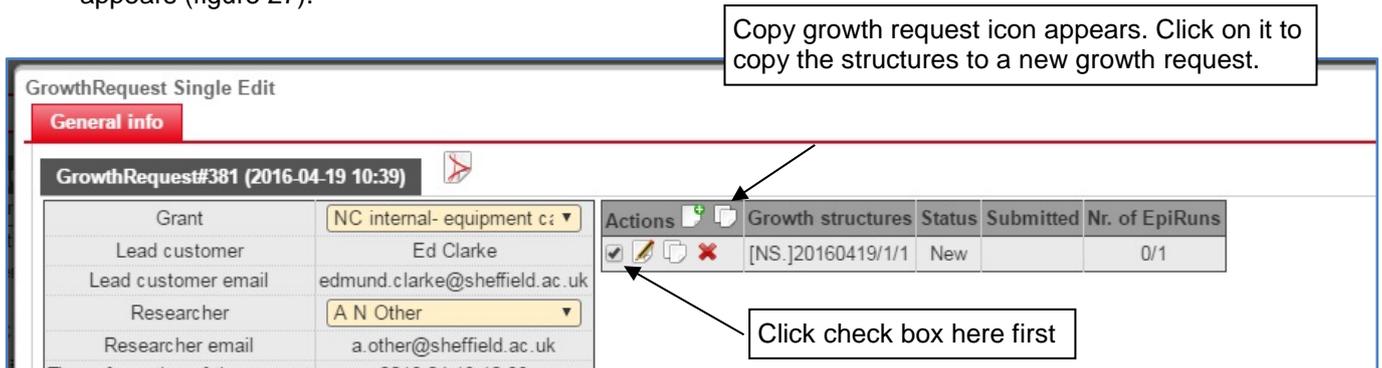


Figure 27 – Activating the copy growth request function

- 3.7.3. Click on the “**Copy growth request**” icon and a new window will open with the structure (or structures with the ticked check box), in a new request. In addition, the newly copied growth request has a new growth reference number and time of creation, as shown in figure 28. As before, the structure (or structures), can be edited just as described in section 3.2 to 3.5.

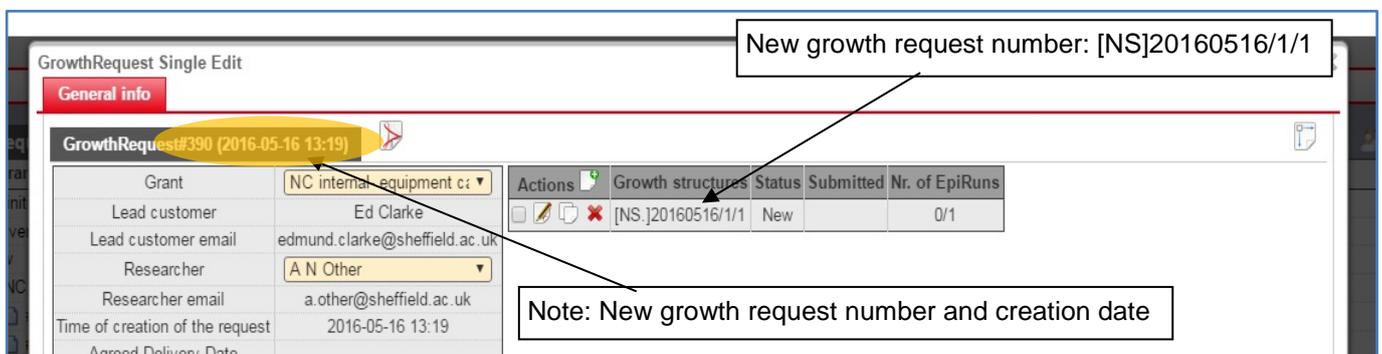


Figure 28 – New copied growth request

#### 4. Export to .pdf

All details of the User's growth request, layer structure, characterization and additional documents, can be summarized in a pdf document simply by clicking on the pdf icon in the corner of the screen, as shown in figure 29. Once downloaded the pdf document will open showing the User the details that have been captured by the epiportal, (see Appendix C for an example). We recommend all Users to do this as it gives them a record of their request.

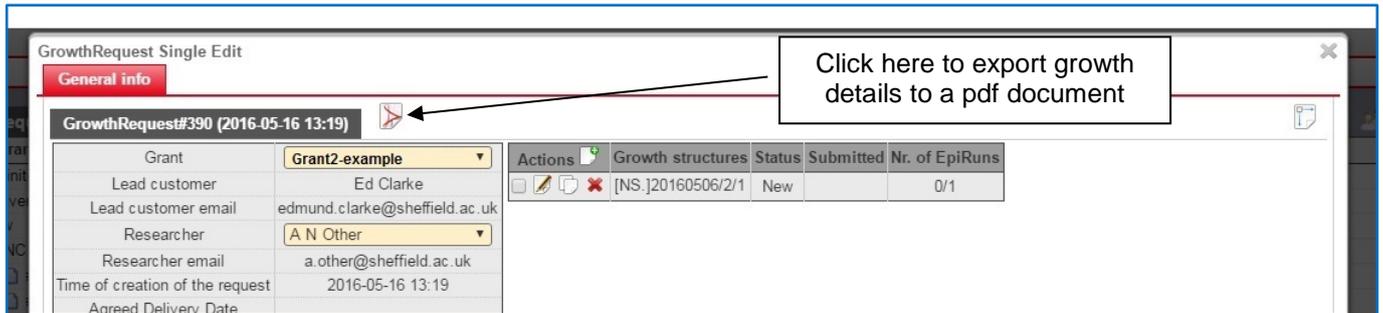


Figure 29 - Exporting to a .pdf document

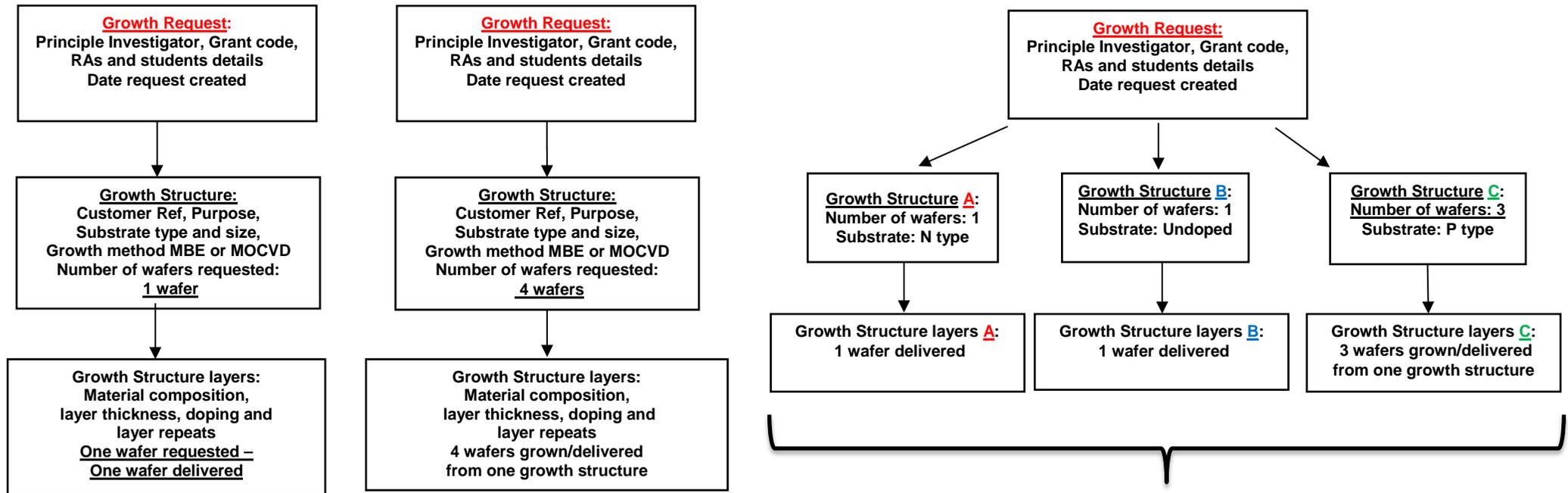
#### 5. Concurrent access to requests

Finally, the system allows multiple people to access the growth request at the same time, however this can lead to problems with multiple edits to data at one time. We have decided to allow concurrent access since it enables two people (e.g. on each end of a phone call) to discuss and build a structure. However, in order to prevent the system crashing it is necessary for one person to edit the structure and the 2<sup>nd</sup> to then refresh the structure (ctrl/cmd+r) before they undertake any editing.

**6. Appendices:**

**6.1. Appendix A – Overview of growth request and growth structures hierarchy**

Below are some examples of the **growth request** and **growth structure** arrangements that are possible through the Epiportal.



**Example 1. – One growth request, one growth structure and one wafer to be delivered**

**Example 2. – One growth request, one growth structure and four wafers to be delivered**

**Example 3. – One growth request, three growth structures and five wafers to be delivered (1 off **A**, 1 off **B** and 3 off **C**)**

Figure 30 - Examples of requests

## 6.2. Appendix B – Status definitions

This appendix gives more details on the status definitions that a User will encounter whilst using the epiportal. They are:

**New:** a new request in the epiportal. This is the status that all Users will come across. Here the growth request and structures can be edited, copied or deleted by the User. The creation of a **“New”** request also sends an automated email to the NEF, alerting the staff that a new request has been placed on the epiportal.

**Definition:** here the User is satisfied that all the details of the request are correct and has clicked on the **“Finish”** button to change the status to **“Definition”**. When the **“Finish”** button is clicked the epiportal issues the message shown in figure 36, asking the User to confirm that they want to change the status of the request.

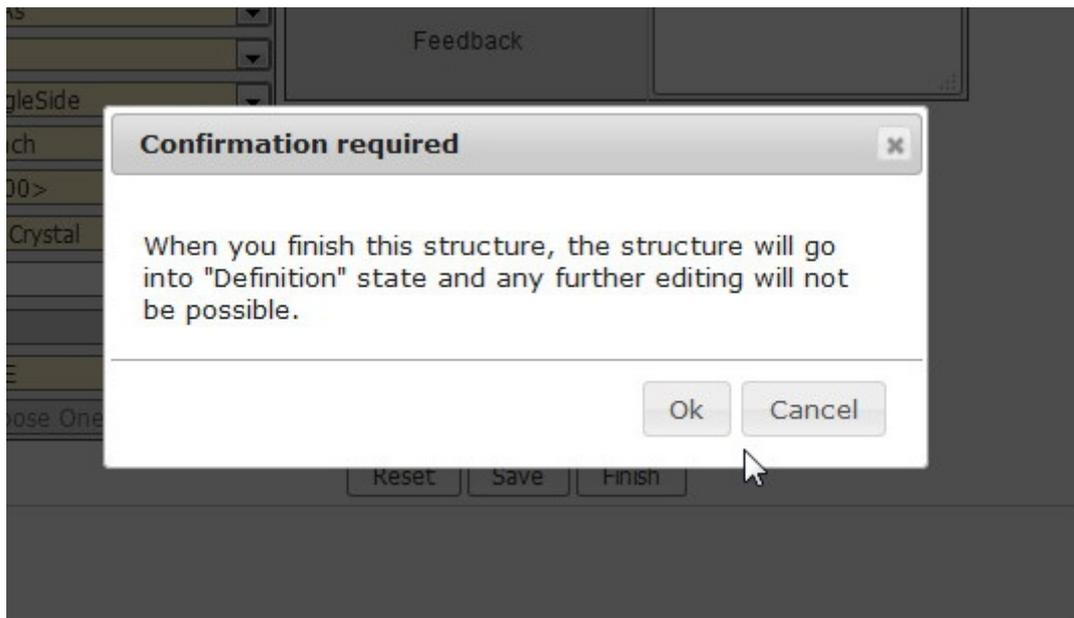


Figure 31 - Confirming the status change to **“Definition”**

Once the request is in this status it can no longer be changed by a normal User. However, if a mistake is made the NEF staff can change the status back to **“New”**, if required. It is also at this point that the relevant production team member will check the request to see if there are any mistakes in the request, or any areas that may need further discussion with the customer, e.g. a growth structure with very tight layer thickness tolerances.

**Submitted:** the next change in the status of the request is from **“Definition”** to **“Submitted”**, which is carried out by the NEF staff. This signifies that the request has passed the checks and has been submitted into the production schedule

**Delivered** – the User’s request has been grown and delivered to the customer. The epiportal request and/or structure is then closed and can no longer be used, except for copying into a new Growth request (as discussed in section 3.7)

Users can check the status of a request at any time by simply logging into the epiportal, selecting the relevant request and viewing the status field entry.

6.3. Appendix C - .pdf example of a User's growth request details.

**EPSRC**  
Engineering and Physical Sciences  
Research Council

**National Centre for  
III-V Technologies**

Universities of Sheffield,  
Cambridge, Glasgow, Nottingham

Epitaxial Growth Request Details

---

**Growth Request**

#       **Grant:** Grant2 - example      **Status:** New  
**Lead customer:** Prof X  
**Researcher:** A N Other  
**Request creation date:** 16 May 2016  
**Agreed delivery date:** Not specified  
**Expected delivery date:** Not specified  
**Actual delivery date:** Not specified  
**Version:** 2      **Request type:** EPSRC  
**Number of growth structure:** 1

**Comments:**

**Feedback:**

---

**Growth Structure**

**Internal reference:** [NS.]20160516/2/1      **Customer reference:** emailtest

**Purpose:**

**Number of supplied wafers:** 1      **Growth method:** MBE  
**Equipment to be used:**  
**Responsible UOS staff member:**  
**Growth structure creation date:** 16 May 2016  
**Agreed delivery date:** Not specified  
**Expected delivery date:** Not specified      **Expected number of runs:** 1  
**Actual delivery date:** Not specified

**Delivery date comment:**

**Status:** New

**Feedback:**

---

**Substrate details**

Material	Doping	Size
GaAs	Undoped	2 inch

**Crystal orientation:** <100>  
**Crystal offcut orientation:** No Crystal  
**Crystal offcut angle [deg]:** 0.0

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**Growth Structure Layers**  
([NS.]20160516/2/1)

Repeats	Thickness	Thickness tolerance	Material	Material tolerance	Doping type	Doping level	Doping tolerance
1	2.0		AlGaN		Undoped	0.0	cm <sup>-3</sup>
1	10.0		GaAs		Undoped	0.0	cm <sup>-3</sup>

EXAMPLE

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Figure 32 - Example of epiportal report document.