Degreased Titanium foil (99.5%) was placed into a poly (methyl methacrylate) specimen holder to form a two sheet configuration. Second, anodizing was carried out via a “two-step” method which involved anodizing the specimen at an initial voltage for 3600 s and then removing the produced oxide layer via adhesive tape. The second step of anodizing was then carried out on the exposed metal/oxide interface under the same conditions as the first step for 600 s. This was immediately followed by a subsequent period of anodizing under a reduced applied voltage in the same electrolyte. The applied voltage was reduced by a factor of $V/n$, where $n = 2, 3$, or 4. The specimens were then analyzed via SEM, STEM, and HR-TEM to determine the resulting nanotube morphology. SEM cross sectional analysis of the oxide film revealed that the nanotubes generated in electrolytes containing only 2wt. % deionized water did not bifurcate when the voltage was reduced. These observations were later reconfirmed by in-depth analysis of the metal/oxide interface after the oxide layer had been peeled off. This result is contradictory to the idea that the diameter of the cell is proportional to the applied voltage and implies there is an underlying mechanism that allows this proportionality to vary depending on growth conditions. Analysis of nanotubes generated in electrolytes with higher water contents revealed that bifurcation became progressively more global as the water content was increased. Additionally, the introduction of a ramped voltage induced less localized bifurcation, as has been previously reported by Chen and Lu [4]. Both, situations imply that an elevated dissolution of the barrier layer plays an important role in the processes leading to a “smooth” bifurcation of nanotubes (figure 1a).

Contrary to these results, it was observed that for higher factors of $n$, bifurcation occurs without a ramped voltage if the voltage remains applied for an extended period of time. This data was in accordance with results published by Albu et al [5] and implies a “non-smooth” bifurcation based on penetration paths forming within the barrier layer (figure 1b). By observing the metal/oxide interface at various times during the development of bifurcation, it was possible to determine that penetration paths are more likely to form at the saddle points of the cell and less likely to form at the triple point. This phenomenon generates distinctive patterns within the scalloped surface of the metal/oxide interface, if the bifurcation process is terminated prematurely (figure 2).

**Fig 1.** SEM images of a) “smooth” and b) “non-smooth” bifurcating TiO$_2$ nanotubes

**Fig 2.** SEM image of a metal/oxide interface with a scalloped pattern generated by incomplete bifurcation.