Questions for the Case Study Tutorial:

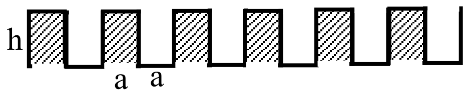
Wetting and super-hydrophobicity

COST-D43 School, Sofia

A. Marmur

April 2011

A rough surface of the shape shown in the figure is given.



1. *Under what conditions is the Wenzel regime more stable than the CB regime?*

2. *Under what conditions can this surface become non-wettable (super-hy**d**rophobic, namely heterogeneous wetting with CA>150^o)?*

The roughness ratio is 2(h+a)/(2a) = 1+h/a. The Wenzel contact angle is then

$$\cos\theta_W = r\cos\theta_Y = (1 + h/a)\cos\theta_Y$$

The Cassie-Baxter eq. reads

$$\cos\theta_{CB} = r_f f \cos\theta_Y + f - 1$$

If the liquid touches only the top surfaces then f=1/2 and r_f=1, so

$$\cos\theta_{CB} = \frac{1}{2}\cos\theta_Y - \frac{1}{2}$$

Now, the Wenzel regime will be more stable as long as the Wenzel contact angle is smaller than the CB one (cos will be higher):

$(h/a + \frac{1}{2})\cos\theta_Y > -\frac{1}{2}$, namely

$$\cos\theta_Y > -\frac{1}{2h/a+1}$$

Since *h/a* must be positive, the Wenzel regime is more stable than the CB regime when the Young CA is smaller than given by this equation. It is worth noticing that it is always more stable when CA<90^o.

To be non-wettable $\cos\theta_{CB} < \cos 150^o$ = -0.866. Thus

$$\cos\theta_{CB} = \frac{1}{2}\cos\theta_Y - \frac{1}{2} < -0.866$$

$$\cos\theta_Y < 1 - 1.732 = -0.732$$

$\theta_Y > 137^{o}$, which does not exist.