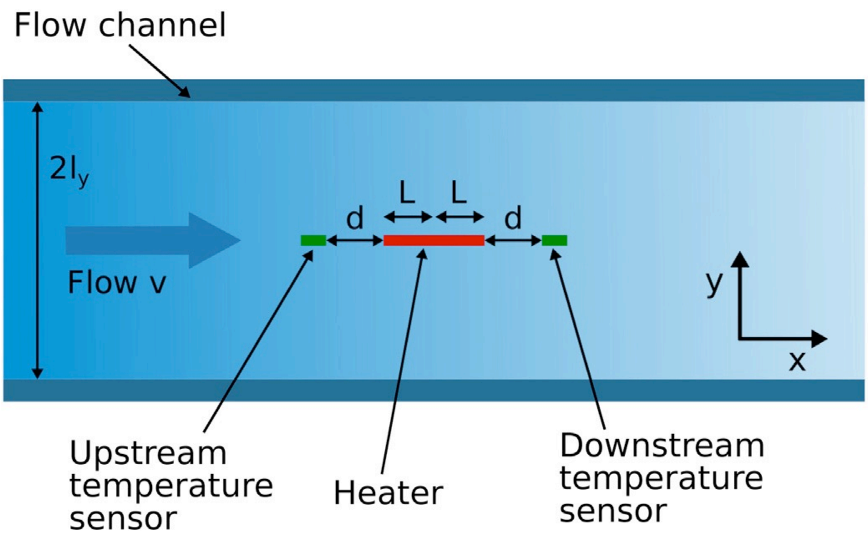
Projet 1 : Micro-capteurs thermiques pour la métrologie des écoulements fluidiques

Avancement Projet nº 2

JIANG Song / HUO Jiaxi / LI Yifei / XIAO Ziyue / YANG Xiao

On étude le fonctionnement d'accéléromètre et essaie de trouver la relation entre **la vitesse de gaz** et **la température de chauffage et deux senseurs** à l'aide de formules que l'on a trouvés dans la référence.
Voici trouver notre résultat par Matlab et COMSOL.

Schéma et principe de fonctionnement :



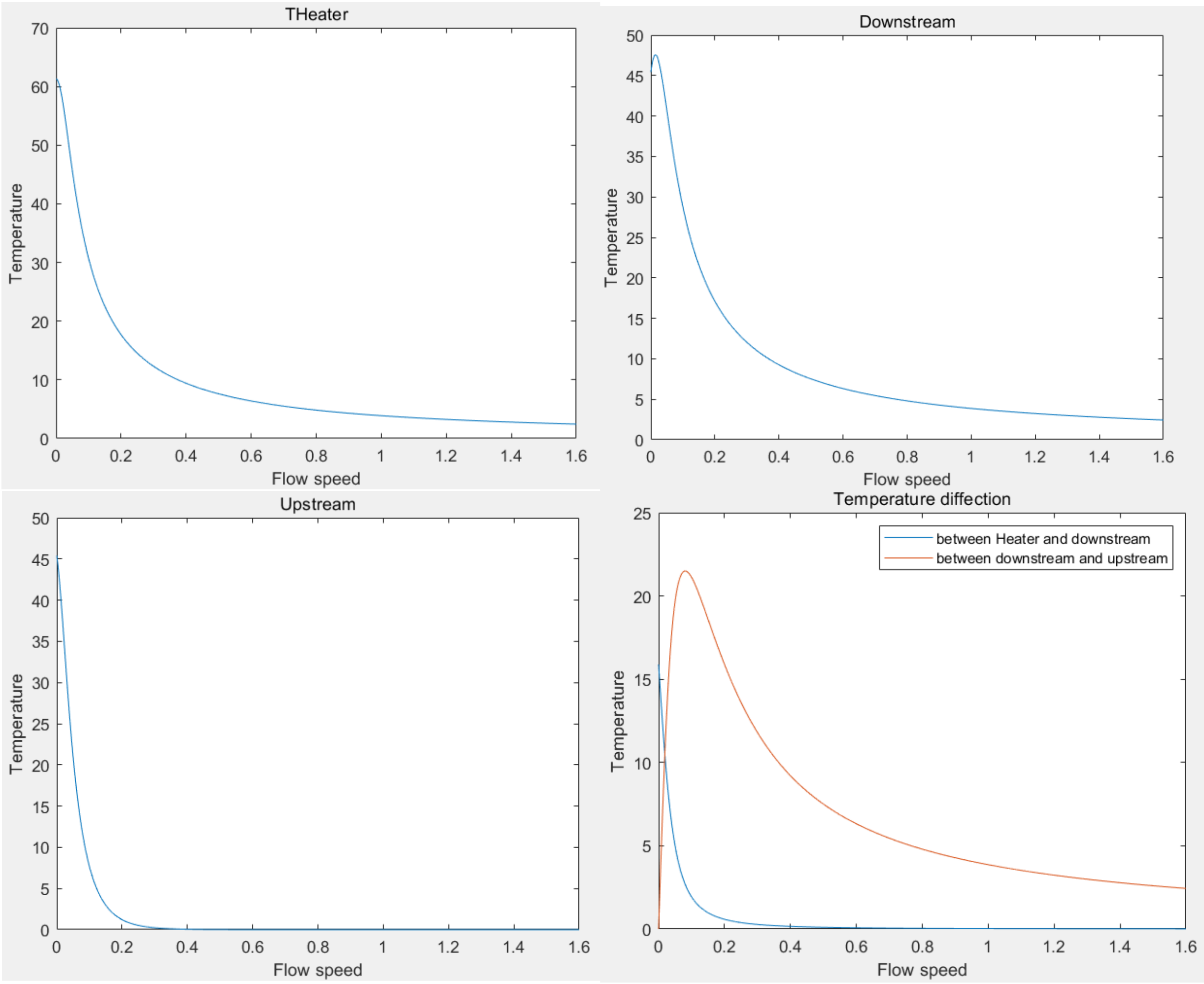
$$T_{down}(v) = T_{Heater}exp(d(\frac{v}{2\alpha} - \frac{1}{2}\sqrt{\frac{v^2}{\alpha^2} + c}))$$

$$T_{up}(v) = T_{Heater}exp(d(-\frac{v}{2\alpha} - \frac{1}{2}\sqrt{\frac{v^2}{\alpha^2} + c}))$$

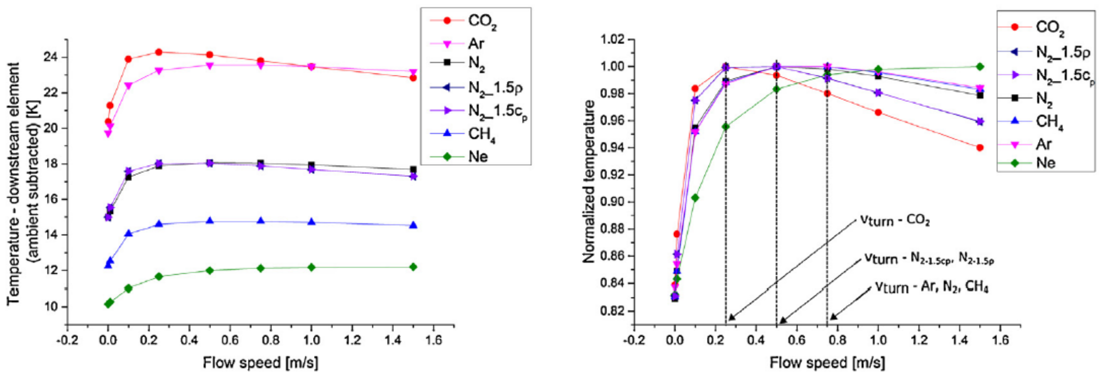
$$T_{Heater} = \frac{P}{a\lambda + b\lambda\sqrt{\frac{v^2}{\alpha^2} + c}}$$

où:
v : Vitesse du fluide
P : puissance de chauffage
a, b, c, d, L : constants géométrique
λ : conductivité thermique du gaz.

I. Calcule sur MATLAB

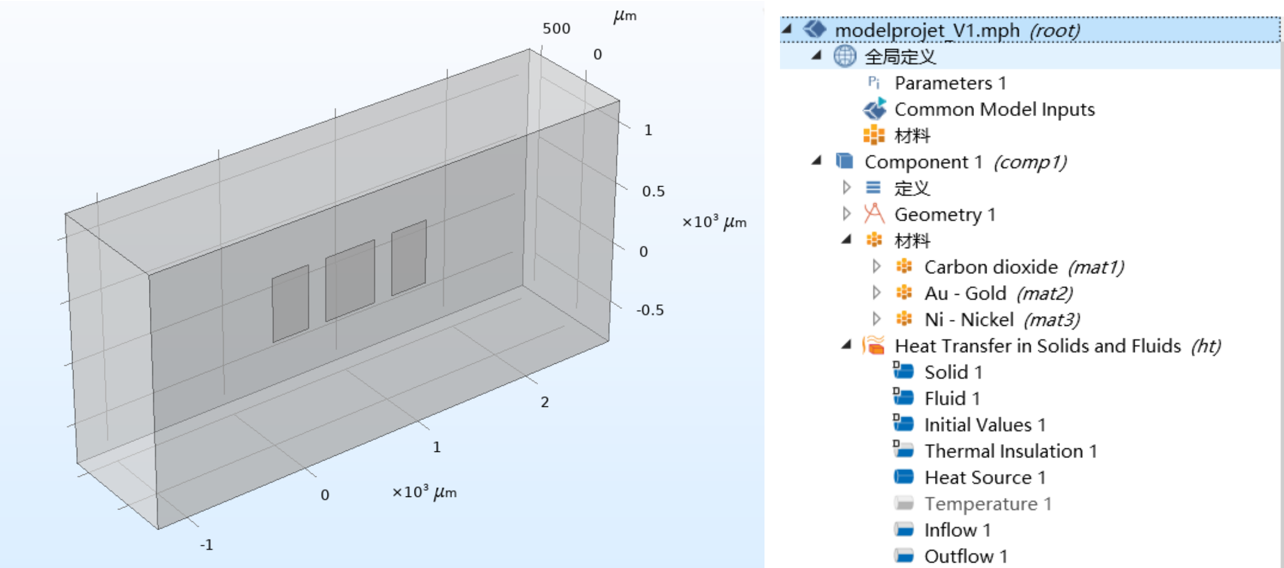


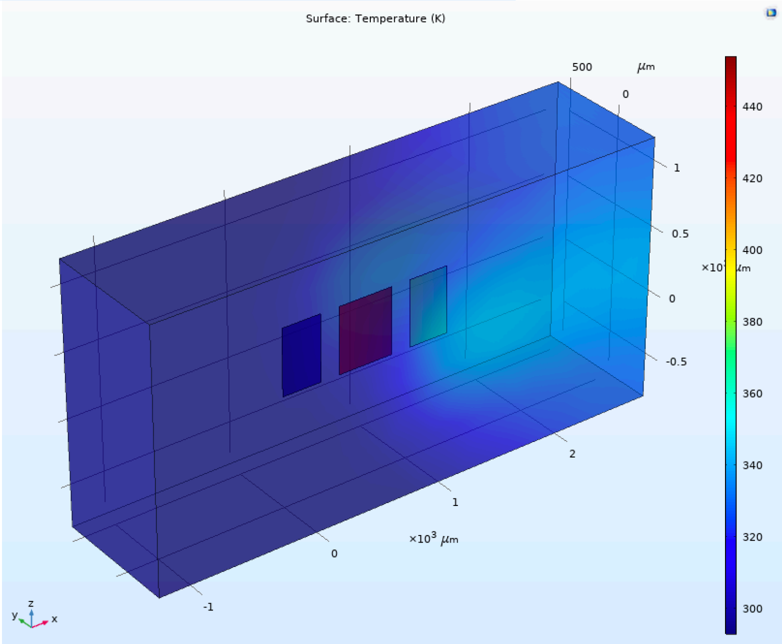
La variation de température en fonction de la vitesse de gaz par simulation



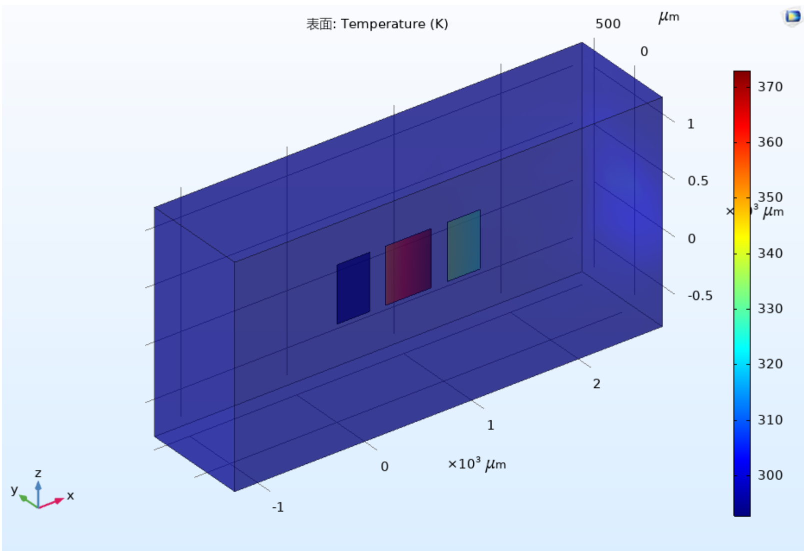
(a) (b)

II. Simulation sur COMSOL

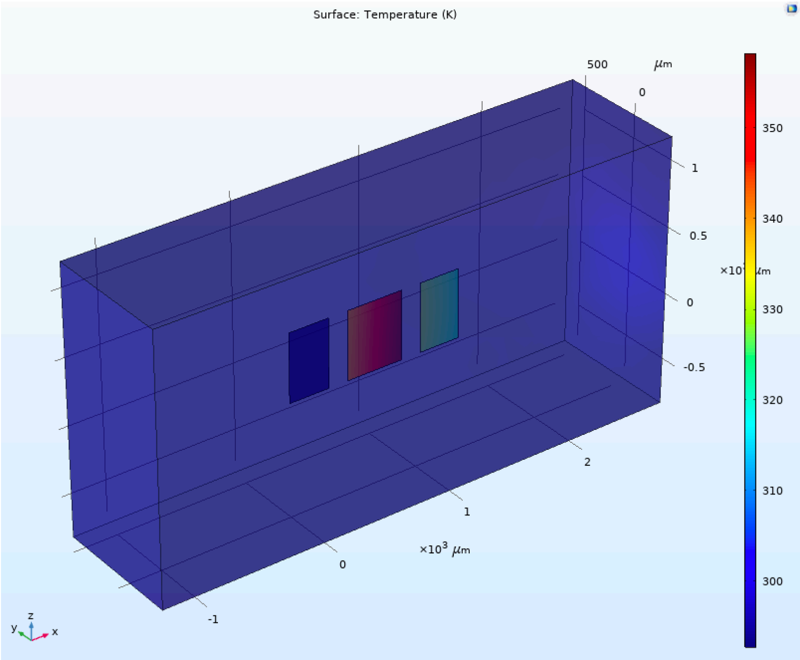

500
µm
0
1
0.5
×10³ µm
0
-0.5
2
1
0
×10³ µm
-1
modelprojet_V1.mph (root)
全局定义
Parameters 1
Common Model Inputs
材料
Component 1 (comp1)
定义
Geometry 1
材料
Carbon dioxide (mat1)
Au - Gold (mat2)
Ni - Nickel (mat3)
Heat Transfer in Solids and Fluids (ht)
Solid 1
Fluid 1
Initial Values 1
Thermal Insulation 1
Heat Source 1
Temperature 1
Inflow 1
Outflow 1


Surface: Temperature (K)
440
420
400
380
360
340
320
300

V=0.1m/s

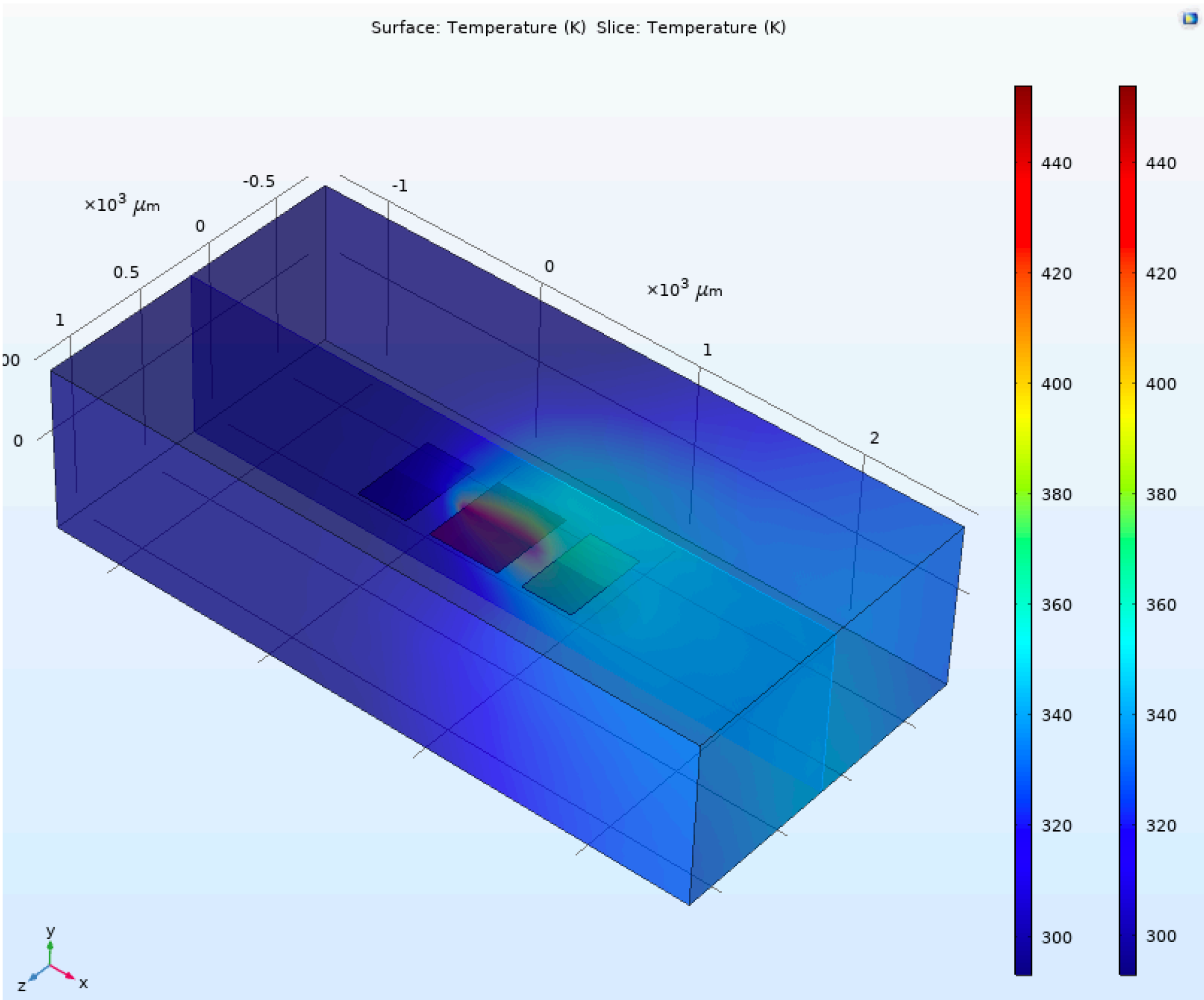

表面: Temperature (K)
370
360
350
340
330
320
310
300

V=1m/s



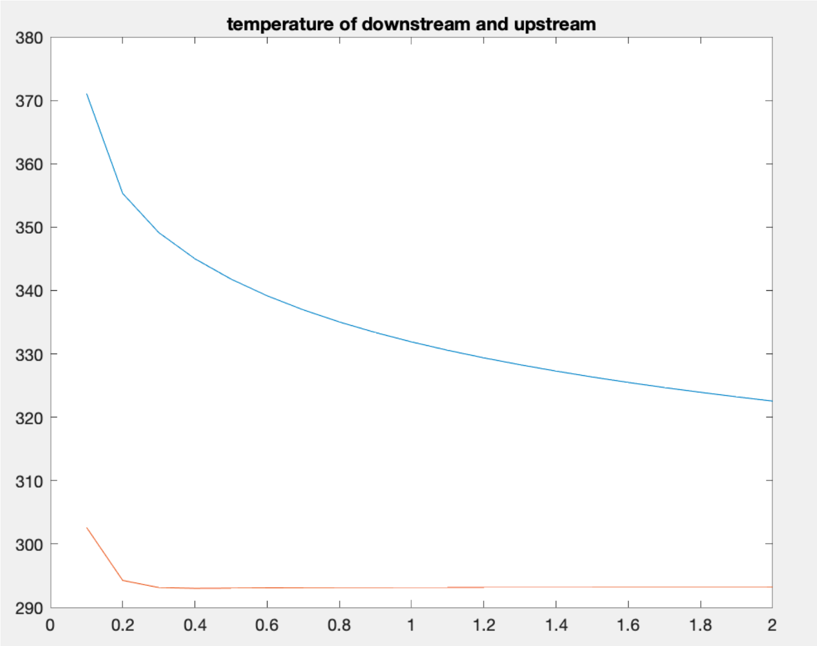
V=1.6m/s

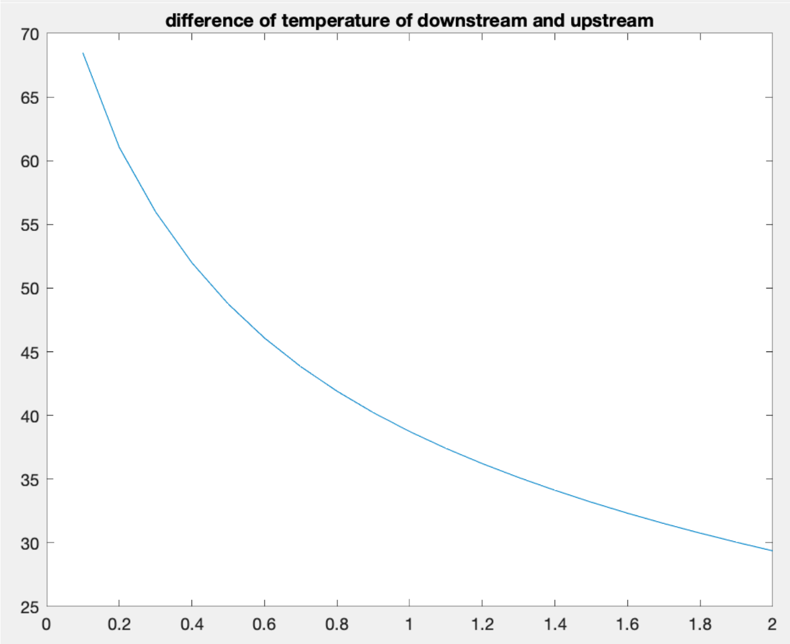
Les résultats que l'on a obtenus correspond bien à celui dans la référence.



III Analyse sous matlab

Température :





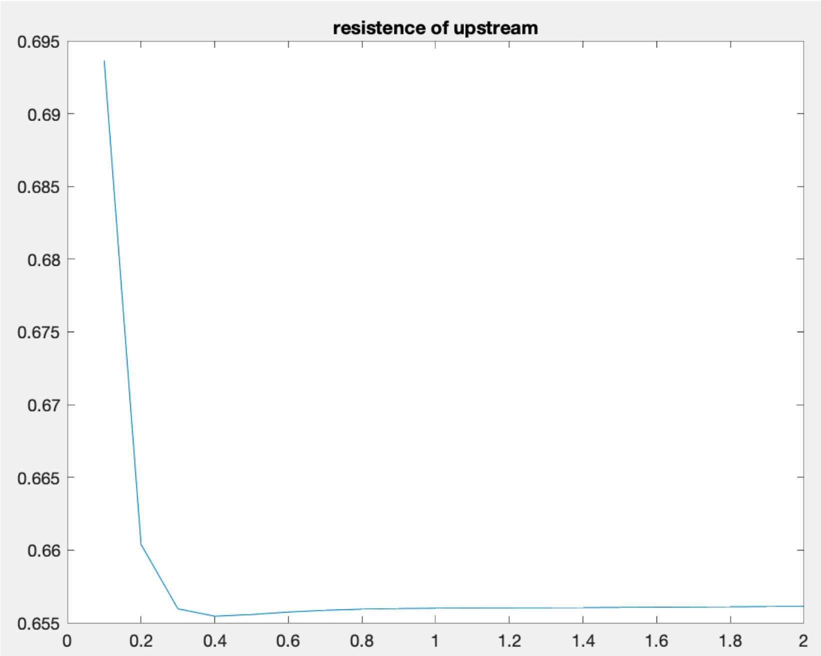
Température et résistance :

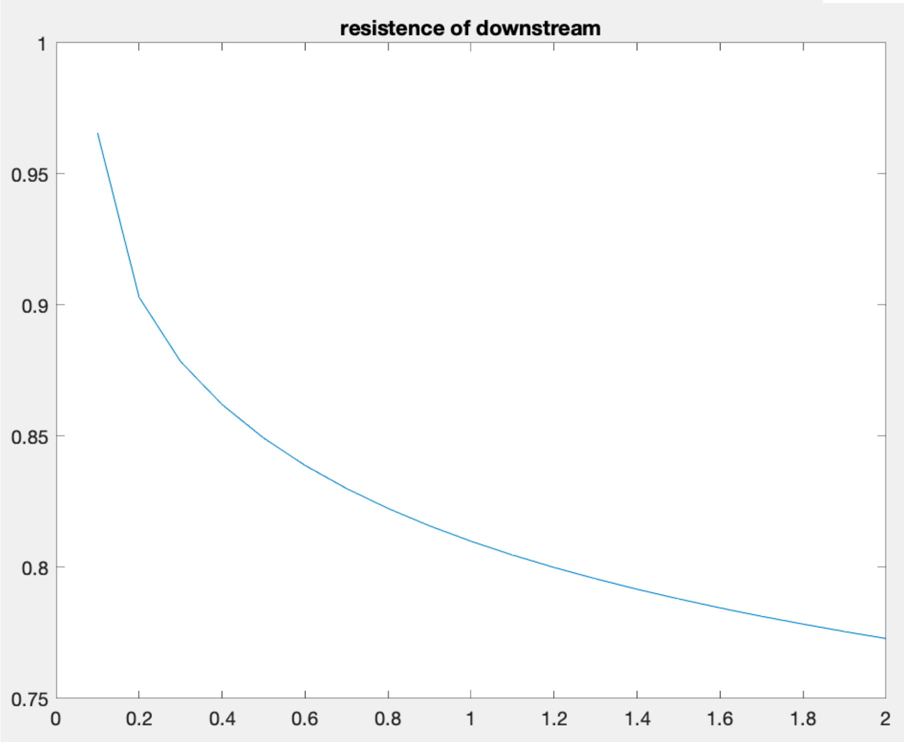
Coefficient de température de résistance α

$$\rho = \rho_0(1 + \alpha T)$$

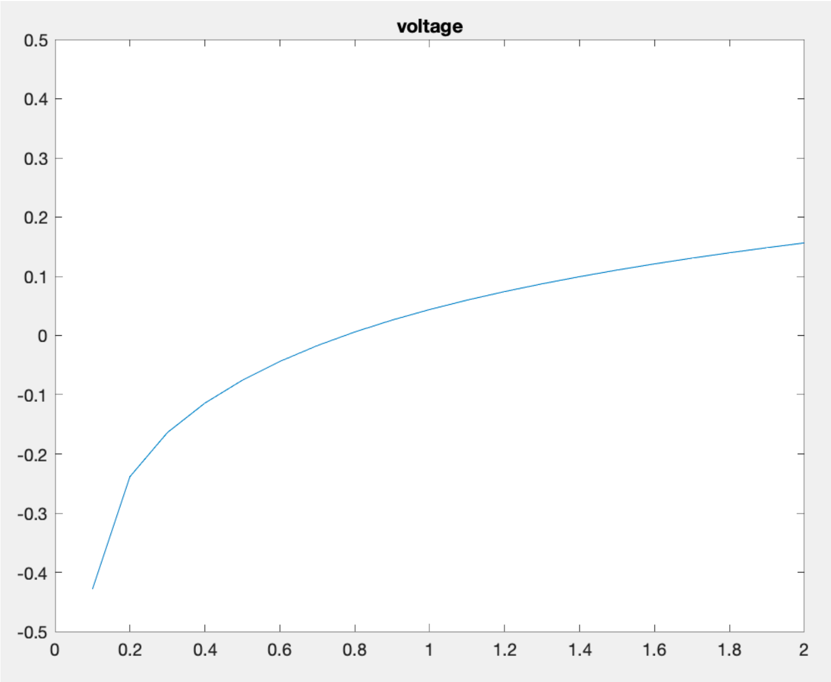
Pour nickel :

$$\alpha = 0.0069/oC^{-1}$$
$$\rho_0 = 6.84e - 8\ \Omega\text{m}$$





Pont de Wheatstone avec seul jauge


voltage
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

Annexe :

```
%% Analyticalmodel of the air
clear
clc
%% Params
% Gas
ro=1.78;% KG/m3
Cp=848.7;
lambda=0.01715;

% Geographique
d=150e-6;
ly=0.5e-3;
lz=2e-3;
L=(427e-6)/2;

%% Model
alpha=lambda/(ro*Cp);
a=2*L*2*lz/ly;
b=2*ly*lz;
c=4/(ly*ly);

% P=12e-3;
Tmax=1.6;
gap=1e-5;

v=0:gap:Tmax;
P=12e-3*ones(1,Tmax/gap+1);

THeater=P./(a*lambda+b*lambda*sqrt(v.^2/(alpha*alpha)+c));

Tdown=THeater.*exp(d*(v/(2*alpha)-sqrt(v.^2/(alpha^2)+c)/2));

Tup=THeater.*exp(d*(-v/(2*alpha)-sqrt(v.^2/(alpha^2)+c)/2));

figure(1)
plot(v,THeater)
title('THeater')
xlabel('Flow speed')
ylabel('Temperature')

figure(2)
plot(v,Tdown)
title('Downstream')
xlabel('Flow speed')
ylabel('Temperature')
figure(3)
plot(v,Tup)
title('Upstream')
xlabel('Flow speed')
ylabel('Temperature')
figure(4)
plot(v,THeater-Tdown)
hold on
plot(v,Tdown-Tup)

title('Temperature diffection')
xlabel('Flow speed')
ylabel('Temperature')
legend(('between Heater and downstream'),('between downstream and upstream'))

disp('Turn point du model downstream')
vturn=alpha*sqrt(c);
disp('speed: ')
```

```
disp(vturn)
disp('Temperatures: ')
Tturn=P(1)/(a*lambda+b*lambda*sqrt(2*c))*exp(d*sqrt(c)*(1/2-sqrt(2)/2));
disp(Tturn)

disp('Turn point analytique downstream')
Tturn_ana=max(Tdown);
vturn_ana=v(find(Tdown==Tturn_ana));
disp('speed: ')
disp(vturn_ana)
disp('Temperatures: ')
disp(Tturn_ana)

disp('We find the point in the model as the temperaure = Tturn')
vturn_model=v(find(Tturn-(1e-3)<Tdown&Tdown<Tturn+(1e-3)));
disp(vturn_model)
```

```
clear;
clc;

v=0.1:0.1:2;
v=v';
upstream=load('upstream.txt')';
downstream=load('downstream.txt')';

figure(1)
plot(v,downstream,v,upstream)
title('temperature of downstream and upstream')

figure(2)
plot(v,downstream-upstream)
title('difference of temperature of downstream and upstream')

ro=6.84e-8;
roT=0.0069;

L=517e-6;
t=2e-7;
W=307e-6;

res_downstream=ro*L/(t*W)*(1+roT*(downstream-273));

res_upstream=ro*L/(t*W)*(1+roT*(upstream-273));

figure(3)

plot(v,res_downstream)
title('resistence of downstream')

figure(4)

plot(v,res_upstream)
title('resistence of upstream')

res_com=ro*L/(t*W)*(1+roT*27);

V=5;

detV=V*(1/2-(res_downstream)/(res_com+res_downstream));
figure(5)
plot(v,detV)
ylim([-0.5,0.5])
title('voltage')
```