Thesis project:

Mucosal rheology in the airways of patients with severe lung disease

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MATLAB DATA ANALYSIS PROGRAMME:

This annex shows the MATLAB script used for analysing the rheological data. The operation of this script was briefly summarised in Chapter n.3 of the thesis.

```
clc
close all
clear all

% Variable ACQUISITION to IDENTIFY tao0, n and k

fileID=fopen('gradient.txt','r');
gamma=fscanf(fileID,'%f');
fclose('all');
fileID=fopen('tao.txt','r');
tao=fscanf(fileID,'%f');
fclose('all');

plot(gamma,tao,'k')
xlabel('Gamma dot [1/s]')
ylabel('Tao [Pa]')
title('FLOW CURVE')
pause


% FIRST APPROACH IDENTIFICATION of tao0

tao0=2.0231;

L=length(tao);
for i=1:L
    nc=i;
    if tao0==tao(i)
        break
    end
end

% TAN-BASED METHOD to IDENTIFY tao0

M=zeros(1,41);
q=zeros(1,41);

M(1)=0;
q(1)=0;
M(2)=0;
q(2)=1;

for i=nc-20:nc+20
        c=polyfit(gamma(1:i),tao(1:i),1);
        M(i)=c(1);
        q(i)=c(2);
end

[m,I]=max(abs(M));
C=[M(I);q(I)];

l=I+10;
hold on
plot(gamma,tao,'k')
plot(gamma(1:l),polyval(C,gamma(1:l)),'r')
plot(gamma(I),tao(I),'*b')
xlabel('Gamma [1/s]')
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```
ylabel('Tao [Pa]')
title('FLOW CURVE')
pause

t0=tao(I-1);
t0old=0;
t0new=zeros(1,(L-I+1));

% OPTIMIZATION of tao0, n and k

for u=1:100000000

lndt=log(tao(I:end)-t0);
lng=log(gamma(I:end));
p=polyfit(lng,lndt,1);
n=p(1);
K=exp(p(2));
flag=0;


if imag(n)~=0
    flag=1;
    break
end

if imag(K)~=0
    flag=2;
    break
end
nmodel=n;
Kmodel=K;

for i=1:L-I+1
    t0new(i)=tao(I-1+i)-K*gamma(I-1+i)^n;
end

sum=0;

for i=1:L-I+1
    sum=sum+t0new(i);
end

tav=sum/(L-I+1);
t0old=t0;
t0=tav;
abs(t0old-t0)

if abs(t0old-t0)<0.1
    flag=3;
    break
end

end

close all

t0v=t0*ones(L);
f= @(x) t0+Kmodel*x.^nmodel;
p0=plot(gamma,tao,'k');p0.LineWidth=1;hold on
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p1=plot(gamma(nc),tao(nc),'*g');p1.LineWidth=2;hold on
p2=plot(gamma(I),tao(I),'*b')
p3=plot(gamma,f(gamma),'-.c')
p4=plot(gamma,t0v,'--r')
legend({'Flow C.','To in','To 1° App.','Flow C. Mod.','To
Raff.'},'Location','east');
title(legend,'Legend');
legend('boxoff');
xlabel('Gamma dot. [1/s]')
ylabel('T [Pa]')
title('FLOW CURVE')
grid on
pause

% Variable ACQUISITION to IDENTIFY taof, taoy , G', G'', G* and tan0

fileID=fopen('G1.txt','r');
G1=fscanf(fileID,'%f');
fclose('all');
fileID=fopen('G2.txt','r');
G2=fscanf(fileID,'%f');
fclose('all');
fileID=fopen('tao_G.txt','r');
taoG=fscanf(fileID,'%f');
fclose('all');

% IDENTIFICATION of taof

deltaG=G1-G2;

for s=5:length(deltaG)
    if deltaG(s)<0
        G1a=G1(s-1);
        G1b=G1(s);
        G2a=G2(s-1);
        G2b=G2(s);
        taoa=taoG(s-1);
        taob=taoG(s);
        break
    end
end

m1=(G1a-G1b)/(taoa-taob);
m2=(G2a-G2b)/(taoa-taob);
q1=G1a-taoa*m1;
q2=G2b-taob*m2;
taof=(q2-q1)/(m1-m2);

%IDENTIFICATION of taoy, G', G'', G* and tan0

v=6;
G1ref=(G1(v)+G1(v+1)+G1(v+2))/3;
sumG1=(G1(v)+G1(v+1)+G1(v+2));
sumG2=(G2(v)+G2(v+1)+G2(v+2));

for r=v:length(G2)
    errG=abs(G1ref-G1(r))/G1ref;

    if errG>0.05 && G1(r)<G1ref
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        break
    end

    sumG1=sumG1+G1(r);
    sumG2=sumG2+G2(r);

end

taoy=taoG(r);
G1model=sumG1/(r-(v-1));
G2model=sumG2/(r-(v-1));
tanmodel=G2model/G1model;
Gsmodel=sqrt(G1model^2+G2model^2);

for w=1:length(G1)
    if t0<taoG(w)
        taoG0=taoG(w-1);
        Gtao0=G1(w-1);
        break
    end
end

close all

p1=loglog(taoG,G1,'r',taoG,G2,'k');hold on
p2=loglog(taoG(w-1),Gtao0,'og');p2.LineWidth=2;hold on
p3=loglog(taoG(r),G1(r),'xb');p3.LineWidth=2;hold on
p4=loglog(taof,(m1*taof+q1),'*m');p4.LineWidth=2;hold on

legend({'G1','G2','To','Ty','Tf'},'Location','southwest');
title(legend,'Legend');
legend('boxoff');
xlabel('Tao [Pa]')
ylabel('G1 G2 [Pa]')
title('SAOS')
grid on

result(1)=t0;
result(2)=Kmodel;
result(3)=nmodel;
result(4)=G1model;
result(5)=G2model;
result(6)=Gsmodel;
result(7)=tanmodel;
result(8)=taoy;
result(9)=taof;
```