Pressure sensor transfer function

Supplementary information in the article

In[1]:=
```
eqn = a (b p^-1/2 - 1) e^Sqrt[c p] + d
values = {a → 106, b → 50, c → 328/1000, d → 15}
```

Out[1]= $d + a\, e^{\sqrt{c\,p}} \left(-1 + \frac{b}{\sqrt{p}}\right)$

Out[2]= $\left\{a \to 106,\ b \to 50,\ c \to \frac{41}{125},\ d \to 15\right\}$

Fit to data

Read data

In[3]:=
```
FileNames[]
```

Out[3]=
```
{b_source_magic.sch, b_source_magic.spice, GTac data (1).csv, GTac data.ods,
 GTac data.pdf, GTac data.png, piezoresistor.sch, PressureXferFunction.nb,
 PressureXferFunctionStrongInv.nb, PressureXferFunctionStrongInv.pdf,
 PressureXferFunctionWeakInv.nb, PressureXferFunctionWeakInv.pdf}
```

In[4]:=
```
datafile = Import["GTac data (1).csv"];
```

In[5]:=
```
Dimensions[datafile]
```

Out[5]= {265, 4}

Format data

In[6]:=
```
rloading = N[ToExpression[Select[Take[#, 2] & /@ Rest[datafile], # ≠ List["", ""] &]]];
runloading = N[ToExpression[Take[#, -2] & /@ Rest[datafile]]];
```

In[8]:=
```
TableForm[rloading]
```

In[9]:=
```
TableForm[runloading]
```

Transform resistance into conductance

In[10]:=
```
gloading = ({#[[1]], 1 / #[[2]]} & /@ rloading) /. 0.0 → 1.*^-10;
gunloading = ({#[[1]], 1 / #[[2]]} & /@ runloading) /. 0.0 → 1.*^-10;
```

In[12]:=
```
TableForm[gloading]
```

In[13]:=
```
TableForm[gunloading]
```

Consolidate data into only one average value per pressure (separate for increasing and decreasing pressure)

In[14]:=
```
glconsolidated = Mean /@ Gather[gloading, First[#1] == First[#2] &];
gunlconsolidated = Mean /@ Gather[gunloading, First[#1] == First[#2] &];
```

In[16]:=
```
TableForm[glconsolidated]
```

In[17]:=
```
TableForm[gunlconsolidated]
```

Fit data

In[18]:=
```
gfunc = g p Sqrt[1 - (p/p2)^2]
```

Out[18]=
$$g\, p \sqrt{1 - \frac{p^2}{p2^2}}$$

In[19]:=
```
fitload = FindFit[gloading, {gfunc, {g > 0, p2 > 0}}, {{g, 0.01}, {p2, 200}}, p]
```

Out[19]=
```
{g → 0.000372767, p2 → 206.422}
```

In[20]:=
```
fitload = FindFit[glconsolidated, {gfunc, {g > 0, p2 > 0}}, {{g, 0.01}, {p2, 200}}, p]
```

Out[20]=
```
{g → 0.000374106, p2 → 204.053}
```

In[21]:=
```
fitunload = FindFit[gunloading, {gfunc, {g > 0, p2 > 0}}, {{g, 0.01}, {p2, 200}}, p]
```

Out[21]=
```
{g → 0.000447106, p2 → 175.92}
```

In[22]:=
```
fitunload = FindFit[gunlconsolidated, {gfunc, {g > 0, p2 > 0}}, {{g, 0.01}, {p2, 200}}, p]
```

Out[22]=
```
{g → 0.000448929, p2 → 174.403}
```

In[23]:=
```
fit = FindFit[Join[gloading, gunloading],
  {gfunc, {g > 0, p2 > 0}}, {{g, 0.01}, {p2, 200}}, p]
```

Out[23]=
```
{g → 0.000410069, p2 → 188.046}
```

In[24]:=
```
fit = FindFit[Join[glconsolidated, gunlconsolidated],
  {gfunc, {g > 0, p2 > 0}}, {{g, 0.01}, {p2, 200}}, p]
```

Out[24]=
```
{g → 0.00041142, p2 → 186.513}
```

In[25]:=
```
Show[ListPlot[{gloading, gunloading},
  Frame → True, FrameLabel → {"Pressure[kPa]", "Conductance[ʊ]"}],
 Plot[Evaluate[gfunc /. # & /@ {fitload, fitunload, fit}], {p, 0, 140}]]
```

Out[25]=