$$\text{magic}(3) \text{ is } \begin{pmatrix} 8 & 1 & 6 \\ 3 & 5 & 7 \\ 4 & 9 & 2 \end{pmatrix}$$

$$\begin{bmatrix} \cos(\phi) & -\sin(\phi) \\ \sin(\phi) & \cos(\phi) \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

$$L\{f(t)\} \equiv F(s) = \int_0^\infty e^{-st} f(t) dt$$

$$e = \sum_{k=0}^{\infty} \frac{1}{k!}$$

$$m\ddot{y} = -mg + C_D \cdot \frac{1}{2} \rho \dot{y}^2 \cdot A$$

$$\int_0^\infty x^2 e^{-x^2} dx = \frac{\sqrt{\pi}}{4}$$

LaTeX, Version Control, and You

Joey Doll
Dec 16, 2009

What are They and Who Cares?

- LaTeX (lah-tech or lay-tech)
  - Typesetting software
  - Based up on TeX, developed by Donald Knuth (Stanford Emeritus Prof). Written because the proofs for his book were horrible
  - Free and open source
  - Compared to Word: plain text format, beautiful output, scales to large projects, equations, easy to edit/share bibliography

What are They and Who Cares?

- Version Control
  - Track changes to files over time
    - Cleaner than saving a copy after every edit
  - Allows multiple people to work on the same project without emailing around files
  - Allows you to roll-back changes
  - Many flavors: Subversion (SVN) and Git are good
    - SVN is installed on your Mac by default
    - Git requires installation but is simpler to use
  - Other version control examples: Dropbox, Google Docs

Installation on your Mac

- Subversion (SVN)
  - Installed by default
  - From the command line run “svn” or GUI option
    - Applications > Utilities > Terminal
- LaTeX
  - One click install with “MacTeX”
    - www.tug.org/mactex/2009/
  - Installs TeXShop (GUI) and LaTeX
- Windows: MikTeX and SVN
- Linux: sudo apt-get install latex kile svn

Like Peanut Butter and Jelly

- LaTeX (plain text typesetting) + SVN (track changes to text and any other files)
- When do I use them?
  - Journal manuscripts
  - Thesis
  - Anything with equations
  - Collaborating/sharing code

Sharing Analysis Code

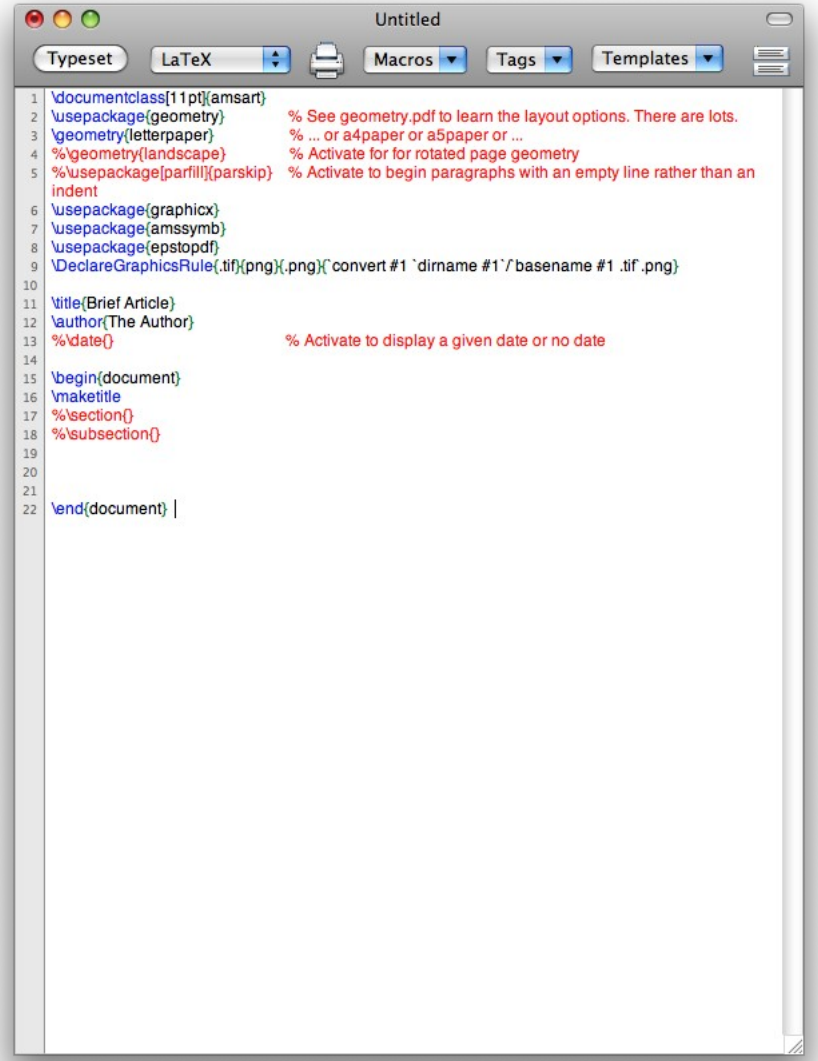
github
SOCIAL CODING

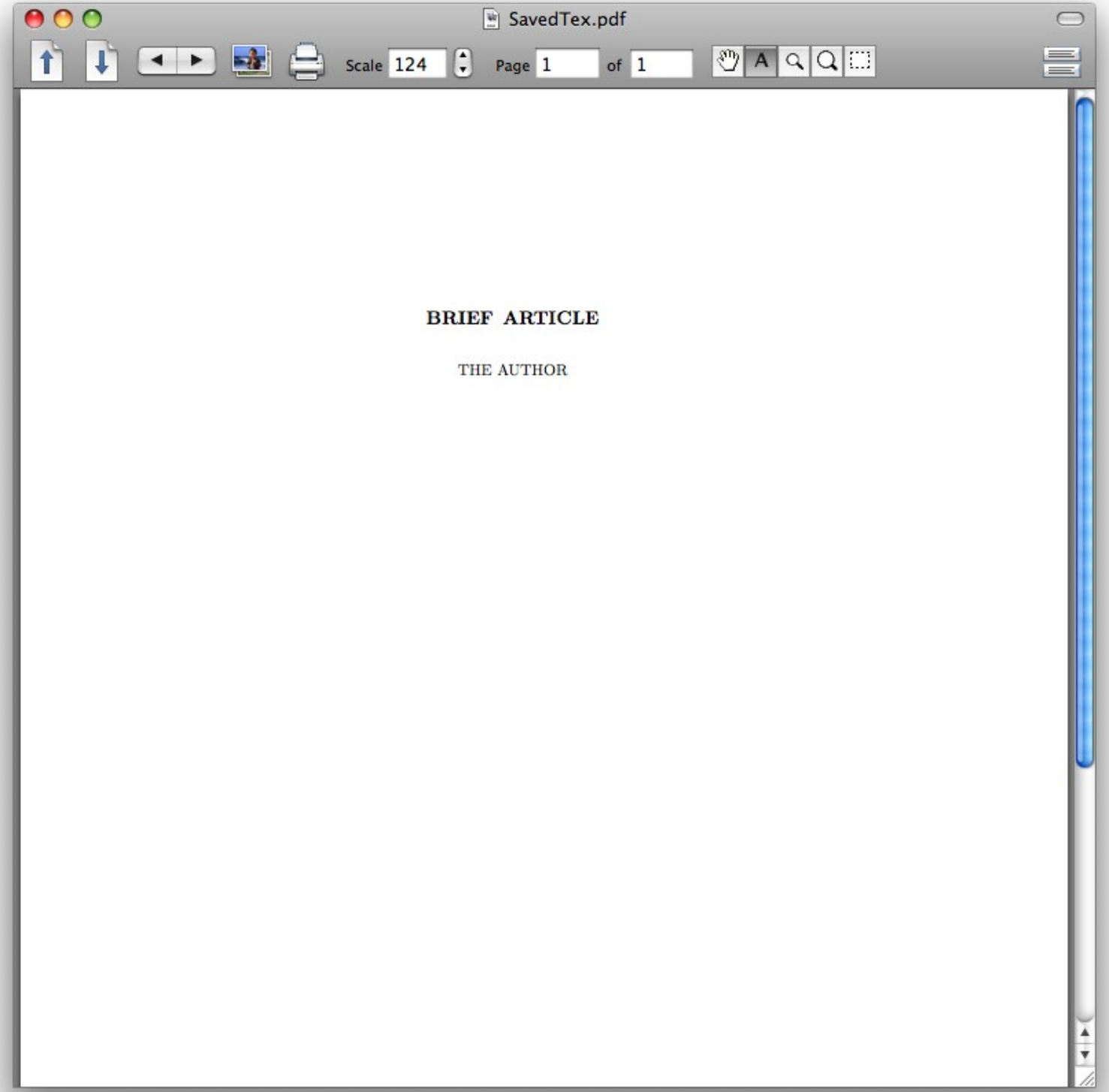
Many other free hosting options too!

Using LaTeX

- So you've installed MacTeX and are using TeXShop?
- Let's make a document with some equations and references

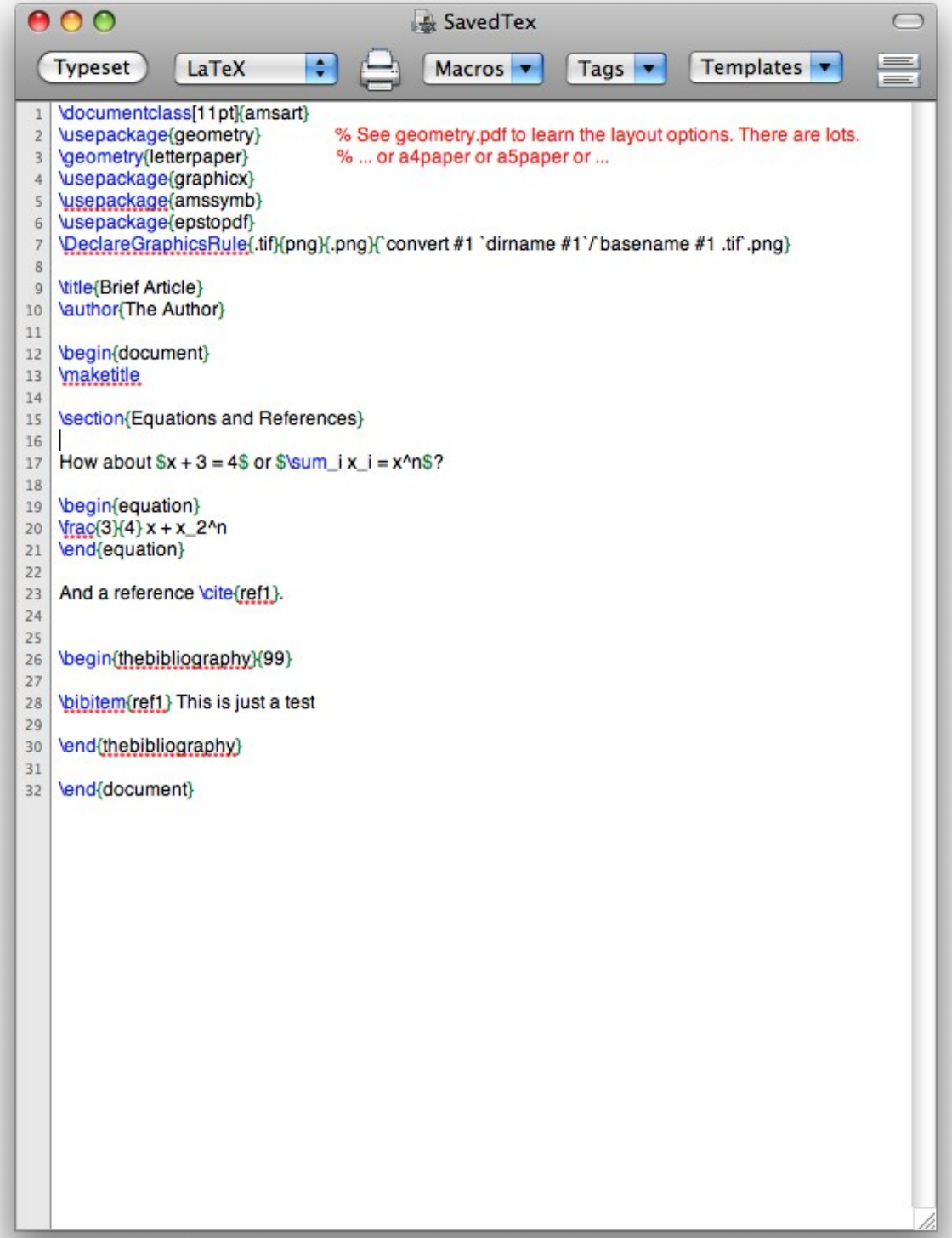
- Select “LatexTemplate” from the Templates
- Click “Typeset”





BRIEF ARTICLE

THE AUTHOR


SavedTex
Typeset
LaTeX
Macros
Tags
Templates
\documentclass[11pt]{amsart}
\usepackage{geometry} % See geometry.pdf to learn the layout options. There are lots.
\geometry{letterpaper} % ... or a4paper or a5paper or ...
\usepackage{graphicx}
\usepackage{amssymb}
\usepackage{epstopdf}
\DeclareGraphicsRule{.tif}{png}{.png}{`convert #1 `dirname #1`/`basename #1 .tif`.png}
\title{Brief Article}
\author{The Author}
\begin{document}
\maketitle
\section{Equations and References}
How about $x + 3 = 4$ or $\sum_i x_i = x^n$?
\begin{equation}
\frac{3}{4} x + x_2^n
\end{equation}
And a reference \cite{ref1}.
\begin{thebibliography}{99}
\bibitem{ref1} This is just a test
\end{thebibliography}
\end{document}

BRIEF ARTICLE

THE AUTHOR

1. Equations and References

How about $x + 3 = 4$ or $\sum_i x_i = x^n$?

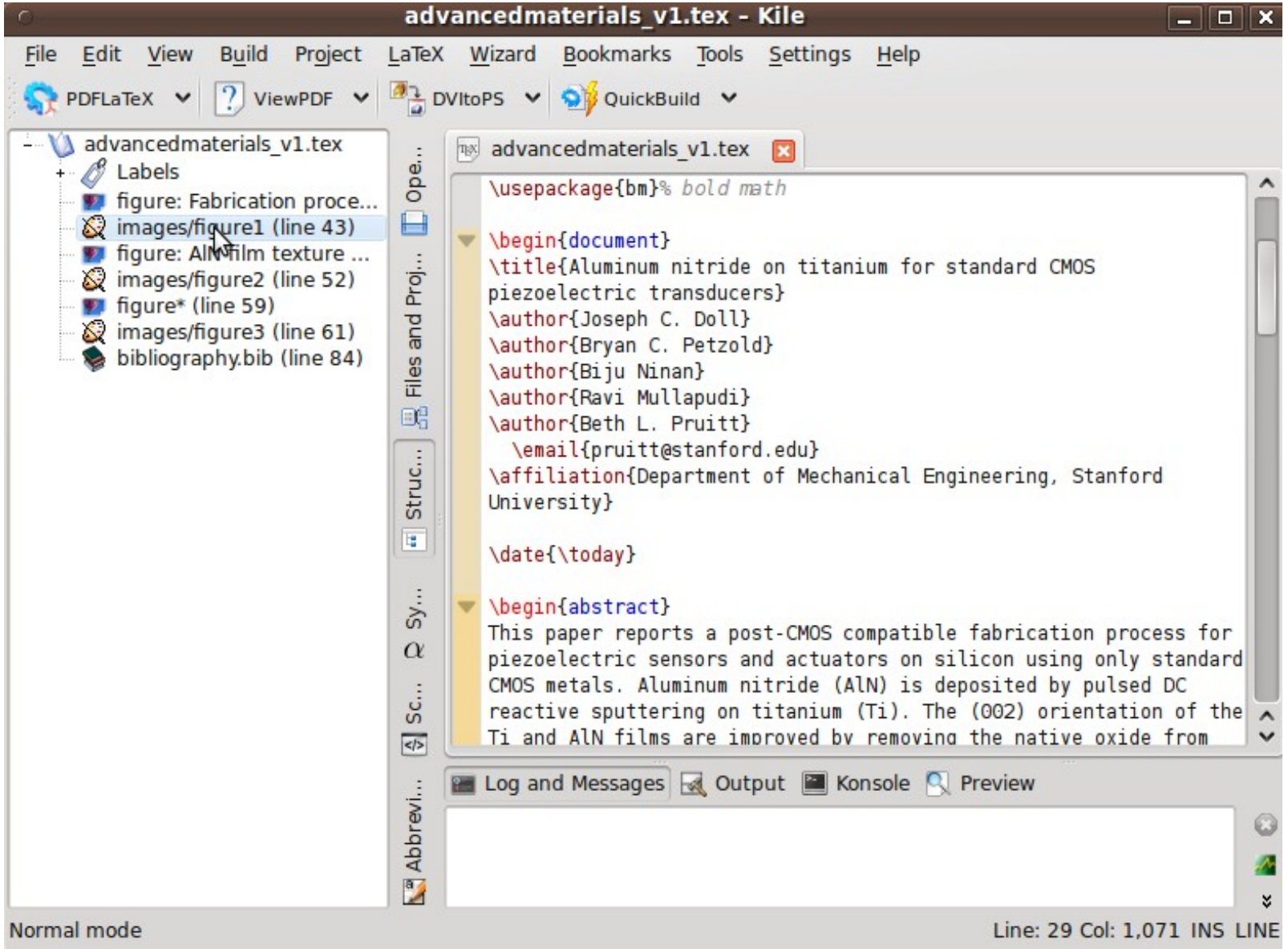
$$\frac{3}{4}x + x_2^n \tag{1}$$

And a reference [1].

References

[1] This is just a test

Journal Example



Journal Example

Aluminum nitride on titanium for standard CMOS piezoelectric transducers

Joseph C. Doll, Bryan C. Petzold, Biju Ninan, Ravi Mullapudi, and Beth L. Pruitt*
Department of Mechanical Engineering, Stanford University
(Dated: June 9, 2009)

This paper reports a post-CMOS compatible fabrication process for piezoelectric sensors and actuators on silicon using only standard CMOS metals. Aluminum nitride (AlN) is deposited by pulsed DC reactive sputtering on titanium (Ti). The (002) orientation of the Ti and AlN films are improved by removing the native oxide from the silicon substrate in-situ and sequentially depositing the films under vacuum to provide a uniform AlN nucleation surface. We measured d_{33f} (2.9 pm/V) and d_{31} (2.3 pm/V) for several AlN thicknesses using laser doppler vibrometery on unpatterned wafers and cantilevers.

High-speed, low-power actuators find numerous applications in microelectromechanical systems (MEMS). Although electrostatic parallel plate and comb drives are widely used for their simplicity, piezoelectric actuators are ideal for high frequency, low voltage applications, such as high-speed atomic force microscopy [1]. Zinc oxide (ZnO) and lead zirconium titanate (PZT) are commonly used piezoelectric materials, but they pose a contamination risk in tools shared with CMOS fabrication processes [2]. Careful processing is required to obtain high resistivity films with both due to the small bandgap of ZnO (3 eV) and the possibility of cracking during sol-gel processing of PZT . In contrast, aluminum nitride (AlN) has a large bandgap (6 eV) and is composed of standard CMOS elements. While the d_{33} piezoelectric response of AlN is less than that of ZnO or PZT [2], its other material properties make it ideal for applications such as electromechanical switches, resonators and filters [3–5].

The deposition of AlN on metal electrodes has been studied extensively for thin film bulk acoustic resonator (FBAR) applications [6]. Although post-CMOS compatible processes have been presented [7–9], they utilize nonstandard metals (e.g. Pt, Cr, Au, Mo) which negate material compatibility benefits of AlN. A CMOS compatible fabrication method for AlN would enable the straightforward processing of piezoelectric materials in a much broader range of processing situations. Here we are comparable, Pt has has been shown to yield better performance to date [12]. Exposure of bottom electrode to oxygen has been shown to affect AlN grain structure and polarity [13], and an amorphous layer of AlN has been found to precede columnar growth when deposited on TiO_2 [14]. These results suggest that the piezoelectric response of AlN on Ti can be improved by investigating the surface condition of the deposition substrate.

We chose to use Ti rather than Al for the metal electrode for its greater performance and process compatibility. Ti(002) has less lattice mismatch (5%) with AlN than Al(111) (23%), reducing strain near the film interface [11]. Etch selectivity between AlN, the electrode material and the Si substrate is also required. Room temperature TMAH etches both Al and AlN but not Ti or Si substantially, providing a CMOS compatible wet etch process.

The AlN and Ti films were deposited in a pulsed DC reactive sputter deposition system (Tango Systems, San Jose, CA). Power, pressure and substrate temperature for AlN deposition were held constant at 5 kW, 5 mtorr and 200°C, respectively. The temperature and pressure were chosen to minimize N incorporation into the Ti and instrinsic stress in the AlN [12]. Target-substrate distance was fixed at 45 mm. All Ti films were sputtered at 3 kW with 40 sccm Ar to yield a deposition rate of 40 nm/min. With a chamber base pressure of 10^{-8} torr, and Ar and N$_2$ flow rates maintained at 10 sccm and 40 sccm, re-

Other Important LaTeX Things

- Use BibTeX for large bibliographies

bibliography.bib

```
1 @article{PetzoldMechanics,
2 author = {Bryan C. Petzold and
3 collaboration = {},
4 title = {The contribution of bc
5 publisher = {},
6 year = {2009},
7 journal = {Proceedings of micrc
```

```
stive cantilevers are well-suited for the stu
 100 $\mu$N), displacements (nm to 10 $\mu$m)
e cantilevers to investigate two fundamental
s \cite{Park:2007p70,PetzoldMechanics} and th
ism for genetics studies, including the study
 signals.
```

```
\bibliographystyle{spphys_nourl}
\bibliography{bibliography}
```

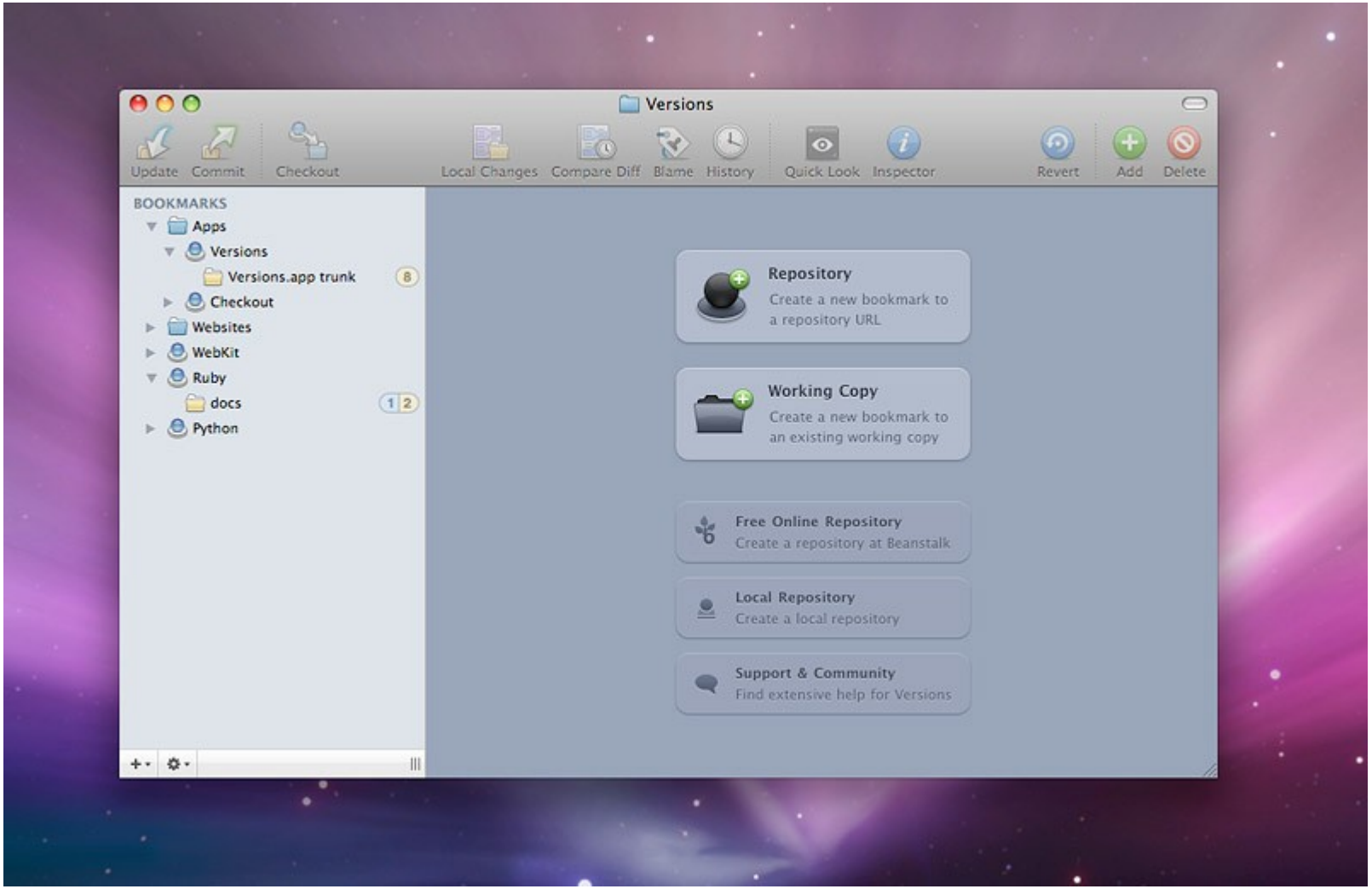
- Use templates (e.g. SUThesis, Journals)
- Inserting Images

```
\begin{figure}[!b]
\centering
\includegraphics[width=4in]{images/processFlow}
\caption{Piezoresistive cantilevers are commonly f
licon micromachining processes. After the wafer is d
uttered to cover the frontside of the wafer and etch
ching from the backside of the wafer (d) followed by
cessary to form low noise, ohmic contacts. An SEM of
oll_Transducers}. \copyright 2009 IEEE.}
\label{fig:1}
\end{figure}
```

Using Subversion

- We'll use SVN from the command line (although GUI options are available)
- We will
  - Create a repository (stores many projects)
    - Just need one repository if working by yourself
    - Often this will be on a server → offsite backup!
  - Create a project and import it
  - Create a text file in the project
  - Play around with the text file

GUI Example: Versions on Mac



Create repo and project, add text file

```
jcdoll@jcdoll-laptop:~$ svnadmin create myRepo
jcdoll@jcdoll-laptop:~$ mkdir jumpingFoxProject
jcdoll@jcdoll-laptop:~$ svn import jumpingFoxProject/ file:///home/jcdoll/myRepo/jumpingFoxProject -m "created project"

Committed revision 1.
jcdoll@jcdoll-laptop:~$ svn checkout file:///home/jcdoll/myRepo/jumpingFoxProject jumpingFoxProject
Checked out revision 1.
jcdoll@jcdoll-laptop:~$ cd jumpingFoxProject/
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ touch lazyDog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ echo "The quick brown fox jumps over the lazy dog" > lazyDog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ cat lazyDog
The quick brown fox jumps over the lazy dog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn status
?       lazyDog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn add lazyDog
A         lazyDog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn commit -m "the fox wins"
Adding         lazyDog
Transmitting file data .
Committed revision 2.
```

Edit the text file and commit

```
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ echo "The slow brown fox runs away from the wiley dog" > lazyDog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn diff
Index: lazyDog
===================================================================
--- lazyDog     (revision 2)
+++ lazyDog     (working copy)
@@ -1 +1 @@
-The quick brown fox jumps over the lazy dog
+The slow brown fox runs away from the wiley dog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn commit -m "the fox runs"
Sending        lazyDog
Transmitting file data .
Committed revision 3.
jcdoll@jcdoll-laptop:~/jumpingFoxProject$
```

Edit and revert

```
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ echo "This doesn't get committed" > lazyDog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn diff
Index: lazyDog
===================================================================
--- lazyDog     (revision 3)
+++ lazyDog     (working copy)
@@ -1 +1 @@
-The slow brown fox runs away from the wiley dog
+This doesn't get committed
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn revert lazyDog
Reverted 'lazyDog'
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ cat lazyDog
The slow brown fox runs away from the wiley dog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$
```

Rollback changes

```
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn merge -r 3:2 .
--- Reverse-merging r3 into '.':
U    lazyDog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ cat lazyDog
The quick brown fox jumps over the lazy dog
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn commit -m "the fox wins again"
Sending        lazyDog
Transmitting file data .
Committed revision 4.
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn update
At revision 4.
jcdoll@jcdoll-laptop:~/jumpingFoxProject$ svn log
------------------------------------------------------------------------
r4 | jcdoll | 2009-12-16 23:11:03 -0800 (Wed, 16 Dec 2009) | 1 line

the fox wins again
------------------------------------------------------------------------
r3 | jcdoll | 2009-12-16 23:08:10 -0800 (Wed, 16 Dec 2009) | 1 line

the fox runs
------------------------------------------------------------------------
r2 | jcdoll | 2009-12-16 23:06:53 -0800 (Wed, 16 Dec 2009) | 1 line

the fox wins
------------------------------------------------------------------------
r1 | jcdoll | 2009-12-16 23:06:02 -0800 (Wed, 16 Dec 2009) | 1 line

created project
------------------------------------------------------------------------
jcdoll@jcdoll-laptop:~/jumpingFoxProject$
```

What You Really Do 99% of the Time

- Work work work
- **svn commit -m “added this section”**
- Work work work
- **svn commit -m “fixed some equation”**
- Work work work
- Oops
- **svn revert**
- Work work work

Things I Didn't Cover

- Git is more intuitive than SVN, but you need to install it
  - `git init`
  - `touch lazyDog`
  - `git add .`
  - `git commit -m “first commit”`
- Storing a project on a server
  - Checkout the project once, then commit/update as usual

The End