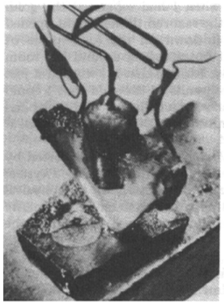
Ciência e Tecnologia de Filmes Finos

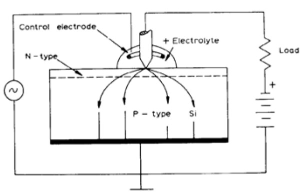
Motivação

Filmes Finos e Aplicações

Quais as aplicações de filmes finos?

Transistor
J. Bardeen
(1951 / Nobel:1956)

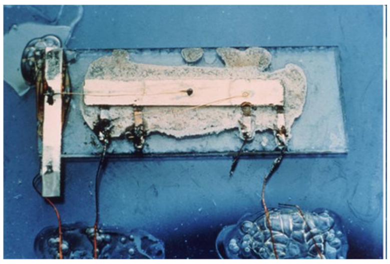




Si/bulk
Czochralski

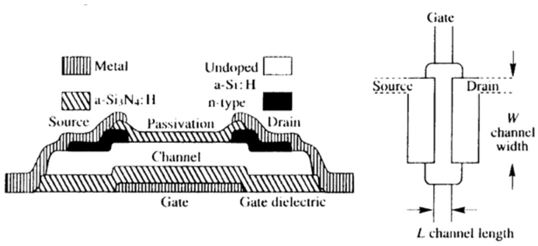
Transistor

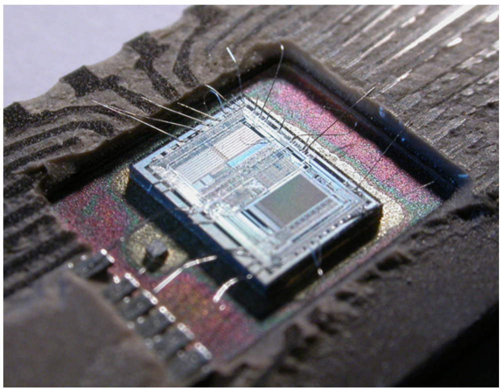
1° Circuito Integrado – Jack Kilby / 1958 (Nobel: 2000).



Contém um único transistor e componentes de suporte em uma lâmina de Ge (1.6 x 11.1 mm).

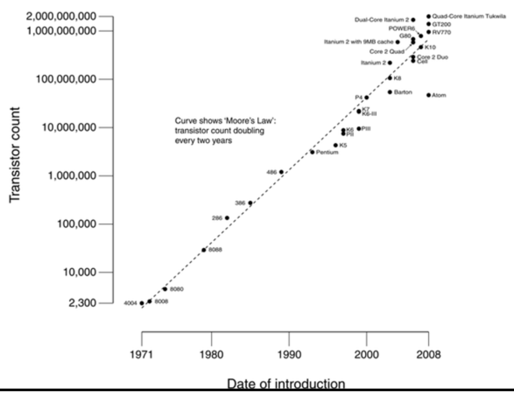
Transistor de Filme Fino





Wikipedia: The integrated circuit from an Intel 8742, a 8-bit microcontroller that includes a CPU running at 12 MHz, 128 bytes of RAM, 2048 byte of EPROM, and I/O in the same chip.

CPU Transistor Counts 1971-2008 & Moore's Law



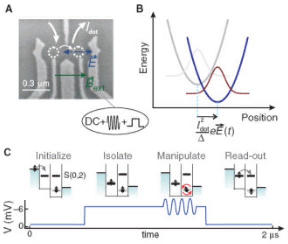


Fig. 1. (**A**) Scanning electron micrograph of a device with the same gate structure as the one used in this experiment. Metallic TiAu gates are deposited on top of a GaAs heterostructure that hosts a two-dimensional electron gas 90 nm below the surface. Not shown is a coplanar stripline on top of the metallic gates, separated by a dielectric [not used in this experiment; see also (*4*)]. In addition to a dc voltage, we can apply fast pulses and microwaves to the right side gate (as indicated) through a homemade bias-tee. The orientation of the in-plane external magnetic field is as shown. (**B**) The electric field generated upon excitation of the gate displaces the center of the electron wave function along the electric field direction and changes the potential depth. Here, Δ is the orbital energy splitting, $l_{dot} = \hbar/\sqrt{m^*\Delta}$ the size of the dot, m^* the effective electron mass, $\hbar$ the reduced Planck constant, and $\mathbf{E}(t)$ the electric field. (**C**) Schematic of the spin manipulation and detection scheme, controlled by a combination of a voltage pulse and burst, $V(t)$, applied to the right side gate. The diagrams show the double dot, with the thick black lines indicating the energy cost for adding an extra electron to the left or right dot, starting from (0,1), where (n,m) ight dot. The energy cost for reaching or (0,2), the energy cost for forming a rming a triplet state (not shown). This ed further in the main text.

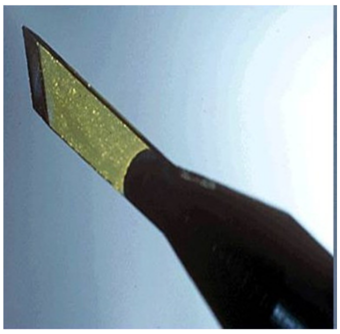
Coherent Control of a Single Electron Spin with Electric Fields
K. C. Nowack, *et al.*
Science **318**, 1430 (2007);
DOI: 10.1126/science.1148092

Eletrônica Processamento ↑

Outras aplicações ↓

Example Application: PDA

http://www.strausberger.com/protective.php



Aplicação: Crescimento de filmes de diamante

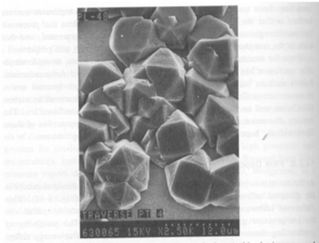
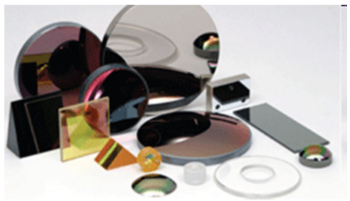


Figure 14-5. Diamond crystals grown by CVD employing combined microwave and filament methods. (Courtesy of T. R. Anthony, GE Corporate Research and Development).

13

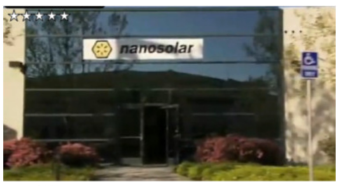
Multicamadas

- Aplicações ópticas



[Janos]

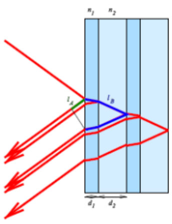
Aplicações

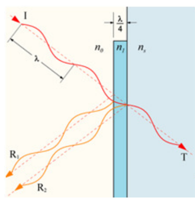


Filmes para recobrimento de vidros arquiteturais

Refletora

Anti - Refletora





Células fotovoltáicas

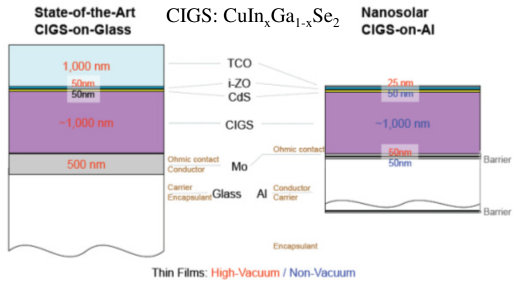
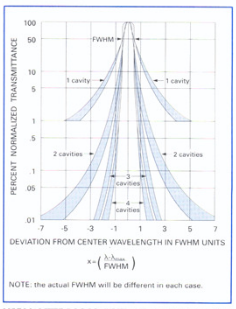
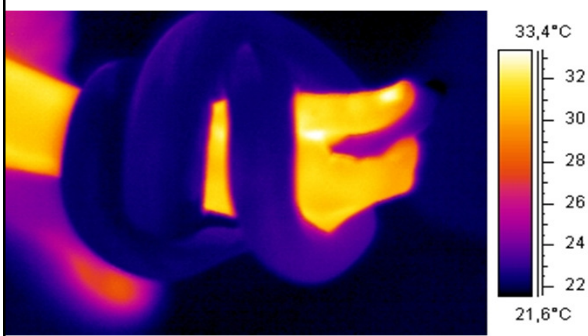


Figure 4: Comparison of State-of-the-Art CIGS versus Nanosolar's CIGS-on-Aluminum. Thickness numbers in red indicate depositions using a high-vacuum deposition technique. The state-of-the-art stack requires close to 3000nm of high-vacuum processing whereas Nanosolar's stack requires less than a tenth of that.

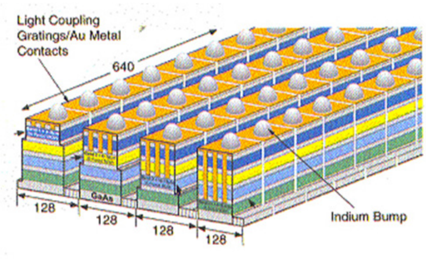


NORMALIZED LOG SCALE TRANSMITTANCE CURVES FOR ZnS/Na$_3$AlF$_6$ BANDPASS INTERFERENCE FILTERS OF 10 nm FWHM (full width at half-maximum), as functions

Sensores Infravermelho



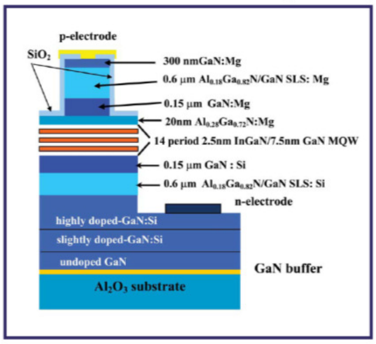
Arranjo matricial de fotodetectores de poços quânticos (QWIP)



4 bandas (cada uma com várias camadas)
cada banda representa uma área de 640x128 pixels

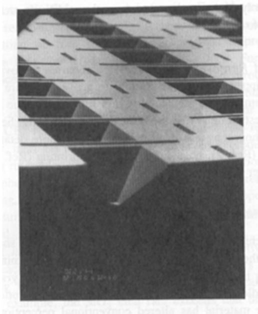
Laser Semicondutor de Cavidade Vertical

Figure 1a: Sheffield Laser diagram
Courtesy: Sheffield University



26 III-Vs REVIEW THE ADVANCED SEMICONDUCTOR MAGAZINE VOL 18 - NO 1 - FEBRUARY 2005

Exemplo : estrutura montada usando fotolitografia e etching seletivo



SEM micrograph of optical microassembly. (Cour
ratories).

24

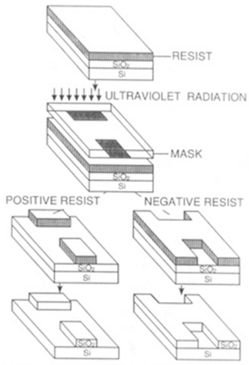


Figure 14-1. Schematic of the lithographic process for pattern transfer from mask to film. Both positive and negative resist behavior is illustrated.

Exemplo : estrutura montada usando fotolitografia e etching seletivo

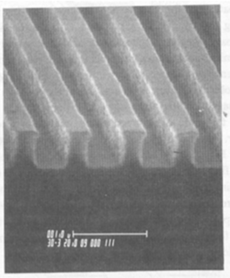


Figure 14-2. SEM micrograph of reactive plasma-etched pattern in photoresist revealing development of submicron features. (Courtesy of L. F. Thompson, AT&T Bell Laboratories).

Exemplo: Escrita e leitura magnética longitudinal e transversal

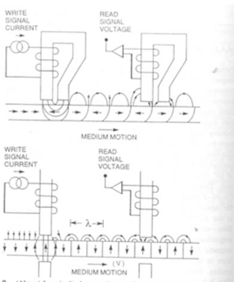
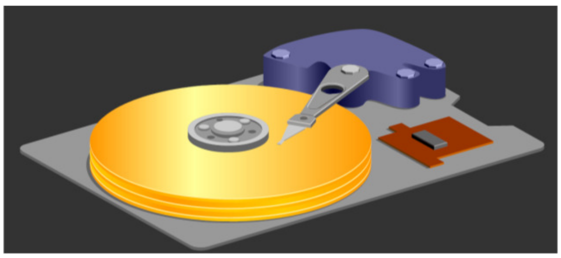
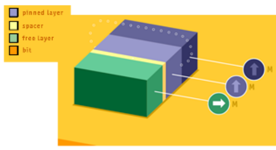


Figure 14-9. (Above) Longitudinal magnetic recording process; (below) perpendicular magnetic recording process. (From Ref. 18 © 1985 Annual Reviews Inc.).





www.research.ibm.com/research/demos/gmr

Exemplo: produção de fita magnética usando deposição de filme

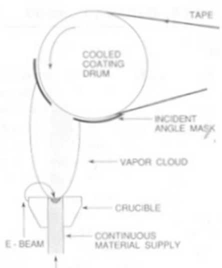


Figure 14-10. Schematic arrangement for continuous oblique evaporation of magnetic films (also undercoats and overcoats) onto a continuous web for video tape applications. The Co–Ni source is evaporated by an electron beam. (Reprinted with permission from IEEE, © 1986 IEEE, from Ref. 20).

29

Aplicação: Processo de escrita e leitura magneto óptica usando filme com propriedades adequadas (ex- HD)

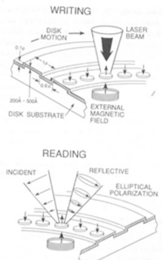


Figure 14-11. Schematic diagram illustrating the writing and reading processes in a pregrooved multilayer magneto-optic disk. (From Ref. 25 with permission from Elsevier Sequoia S.A.).

30

Aplicação: Esquema de um analisador óptico integrado que usa propriedades piezo-elétricas de filme de LiNbO:Ti

14.7. Superlattices 661

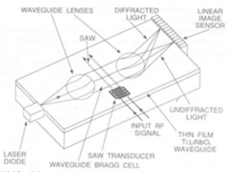


Figure 14-15. Schematic of the integrated optics rf spectrum analyzer (From Ref. 33).

31

<u>Por que depositar filmes finos?</u>

32

• Economia: menor quantidade de material

•Praticidade: menor tamanho

•Qualidade: menor densidade de defeitos ou impurezas (que o substrato)

33

•Obtenção de novas propriedades:

* Engenharia de bandgap
(Ex. Hetero-estruturas/lasers)

* Níveis de energia
ajustáveis/confinamento (ex: HEMT).

34

Propriedades não acessíveis ou dificilmente acessíveis para substratos descobertos

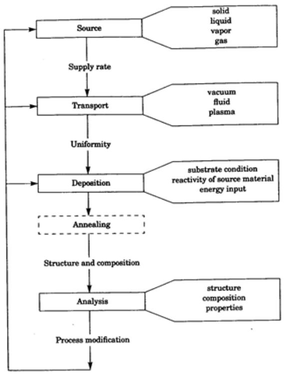
35

TABLE 1.1 Thin-Film Applications

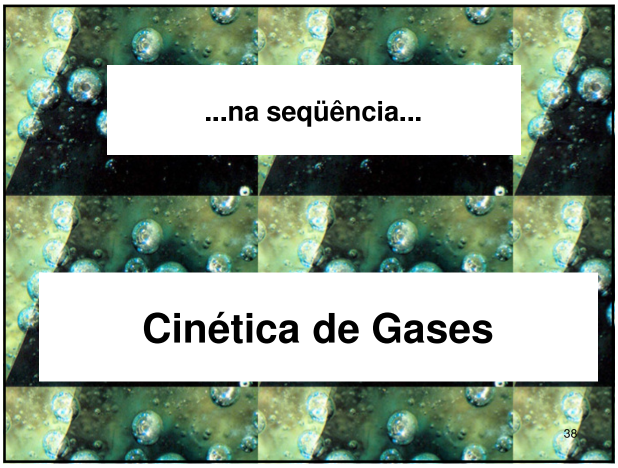
Thin-film property category	Typical applications
Optical	Reflective/antireflective coatings Interference filters Decoration (color, luster) Memory discs (CDs) Waveguides
Electrical	Insulation Conduction Semiconductor devices Piezoelectric drivers
Chemical	Barriers to diffusion or alloying Protection against oxidation or corrosion Gas/liquid sensors
Mechanical	Tribological (wear-resistant) coatings Hardness Adhesion Micromechanics
Thermal	Barrier layers Heat sinks

36

Etapas da deposição de filmes finos



37



Aula 1