

PIONEERING ELECTROCHEMISTRY

Colin Fink was a pioneer in electrochemical processing of materials.

Fink is best known for his ground-breaking developments in the electro-deposition of metals, and particularly for establishing how the chromium electrodeposition process influences the resulting material properties.

He developed and patented a commercial process for chromium plating that is, even today, ubiquitously applied throughout the world to create shiny, bright, non-tarnishing, corrosion resistant, hard and durable finishes.

His work not only established the mechanics for chromium electroplating but he also was responsible for developing a process leading to ductile tungsten for incandescent lamp filaments, an insoluble anode used in the copper mining process, and an electrolytic process for the faithful restoration of corroded ancient bronzes. Professor Fink played an active role in The Electrochemical Society, and has been credited with saving the society during the depression.

Many students followed in Professor Fink's footsteps in the field of electrochemistry, including Samuel Ruben. Ruben was associated with both Physics and Chemical Engineering and his invention of the alkaline battery led to the company now known as Duracell. His name lives on at SEAS as an endowed professorship established in his honor.

Engineers throughout Columbia Engineering continue this tradition of excellence in materials science, employing the most advanced tools and theories to develop ever more sophisticated materials.



COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science

PIONEERING ELECTROCHEMISTRY

Colin G. Fink (1881-1966)
BS'03, ChemE Faculty 1921-50

Developed and patented
chromium plating process



Feb. 28, 1933.

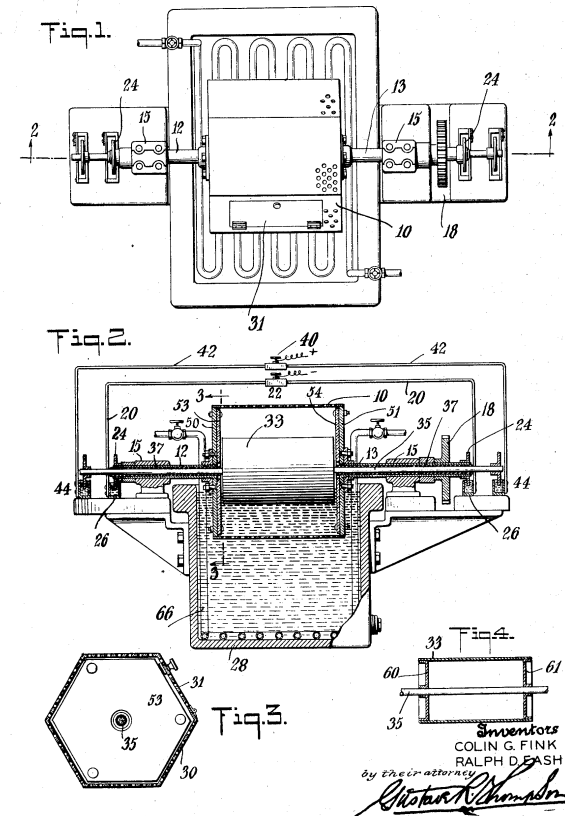
C. G. FINK ET AL

1,899,679

BARREL PLATING APPARATUS AND PROCESS

Filed June 3, 1926

2 Sheets-Sheet 1





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The Fu Foundation School of Engineering and Applied Science

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Developed and patented
chromium plating process

Creates shiny, bright, non-
tarnishing, durable finish

Invented process to produce
ductile tungsten for
incandescent lamp filaments

Taught Samuel Ruben, who
invented alkaline battery
(Duracell Company)

June 24, 1924.

C. G. FINK
EVACUATED CONTAINER
Filed Jan. 23, 1916

1,498,908

Fig. 1.

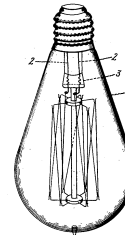
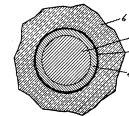


Fig. 2.



Witnesses:
J. W. Allen

Inventor:
Colin G. Fink,
by *W. H. Davis*
His Attorney.



It would be a dramatic understatement to say that a lot has changed since Professor Fink returned to Columbia in 1921 and began his pioneering work. In fact, there was a revolution in physics, whereby we accepted that the long held laws of classical physics cease to work at very small scales, and that the recently discovered elementary particles are governed by the laws of quantum physics. In the past century, we have developed a profound understanding of these new laws, and a current challenge is to now apply these laws with quantitative accuracy and engineer the world around us.

In my research I focus on predicting materials properties starting from the first-principles of quantum mechanics, including mechanical, magnetic, and electronic properties.

My research efforts include both developing new theories of electronic structure and the application of existing methodologies to understand and design new materials. Executing my research plan hinges upon the use of high performance supercomputers, whose ever increasing power allows us to address higher degrees of complexity every year.

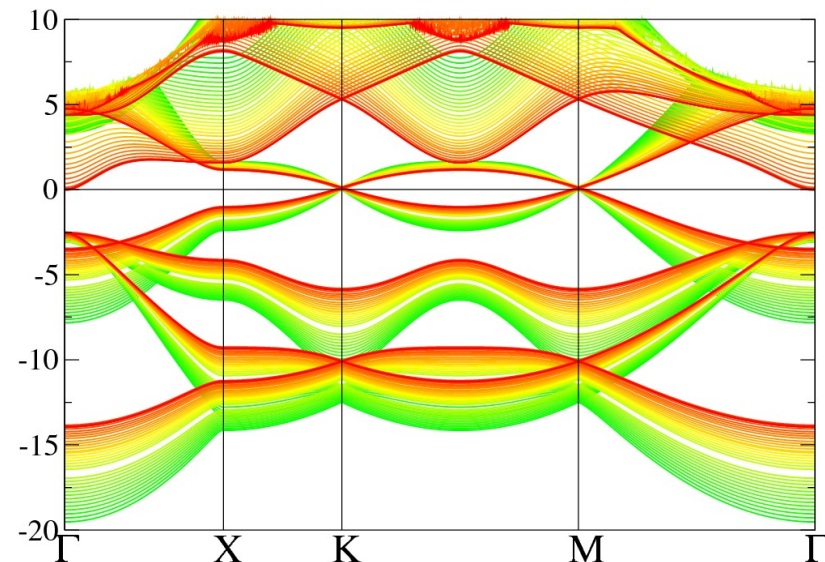
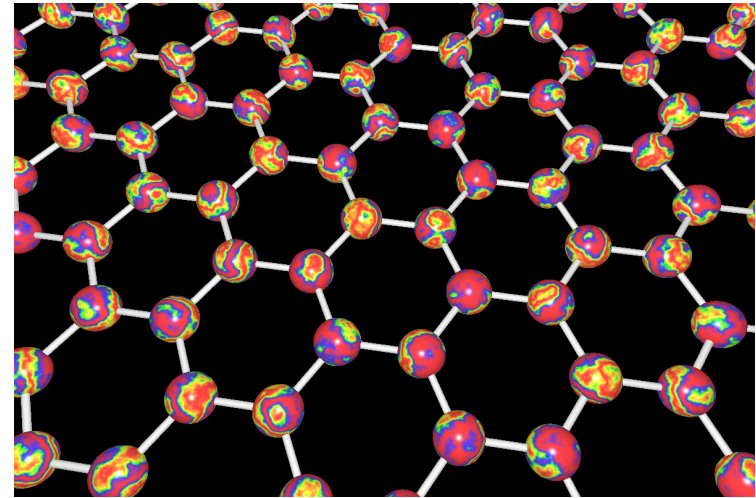
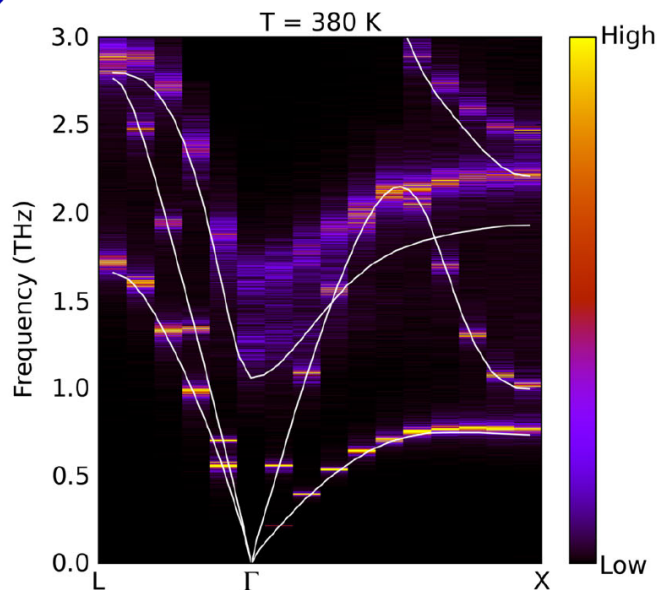
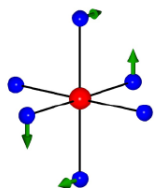
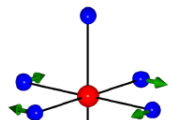
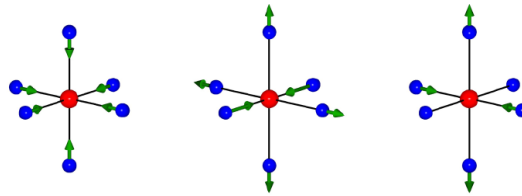
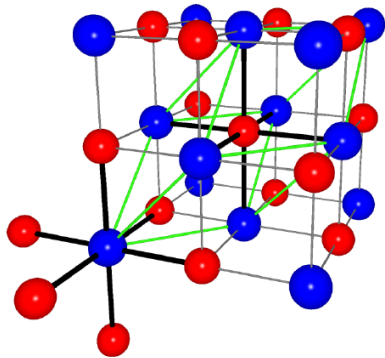
I study a wide range of materials which literally span the entire periodic table, ranging from hydrogen to curium.

In particular, I am interested in materials which have potential applications for energy storage or conversion, such as battery cathodes, nuclear reactor fuels, and thermoelectrics. I also have a strong interest in two-dimensional materials, which give a whole new meaning to the notion of a “thin coating”. While graphene kicked off the revolution of two-dimensional materials, there is now an ever growing library of two-dimensional materials including BN, MoS₂, TaS₂, phosphorene, and many others. Stacking these different two-dimensional materials in various ways could lead to unprecedented properties and novel devices.

We have truly entered a new era, where materials may be designed virtually and fabricated one atomic layer at a time. I am humbled to be part of this great tradition, and very proud to be carrying out this research in SEAS.

Vision:

Predicting materials properties from first-principles of quantum mechanics



Vision:

Predicting materials properties from first-principles of quantum mechanics

Approach:

Sophisticated mathematical formalisms & massive supercomputers



$$H = \sum_{\sigma} \int d\mathbf{r} \psi_{\sigma}^{\dagger}(\mathbf{r}) \left[-\frac{1}{2} \nabla^2 + V_{ext}(\mathbf{r}) \right] \psi_{\sigma}(\mathbf{r}) + \frac{1}{2} \sum_{\sigma\sigma'} \int d\mathbf{r} d\mathbf{r}' \psi_{\sigma}^{\dagger}(\mathbf{r}) \psi_{\sigma'}^{\dagger}(\mathbf{r}') \frac{1}{|\mathbf{r}-\mathbf{r}'|} \psi_{\sigma'}(\mathbf{r}') \psi_{\sigma}(\mathbf{r})$$

$$\Gamma[\rho, G_{cor}; V^{Hxc}, \Sigma] = \text{Tr} [\ln G] + \Phi[\rho, G_{cor}] - \text{Tr}[V^{Hxc} \rho] - \text{Tr}[\Sigma_{cor} G_{cor}]$$

1																		2																	
H Hydrogen																		He Helium																	
3 Li Lithium				4 Be Beryllium								5 B Boron				6 C Carbon				7 N Nitrogen				8 O Oxygen				9 F Fluorine				10 Ne Neon			
11 Na Sodium				12 Mg Magnesium								13 Al Aluminum				14 Si Silicon				15 P Phosphorus				16 S Sulfur				17 Cl Chlorine				18 Ar Argon			
19 K Potassium																		20 Ca Calcium																	
21 Sc Scandium																		22 Ti Titanium																	
23 V Vanadium																		24 Cr Chromium																	
25 Mn Manganese																		26 Fe Iron																	
27 Co Cobalt																		28 Ni Nickel																	
29 Cu Copper																		30 Zn Zinc																	
31 Ga Gallium																		32 Ge Germanium																	
33 As Arsenic																		34 Se Selenium																	
35 Br Bromine																		36 Kr Krypton																	
37 Rb Rubidium																		38 Sr Strontium																	
39 Y Yttrium																		40 Zr Zirconium																	
41 Nb Niobium																		42 Mo Molybdenum																	
43 Tc Technetium																		44 Ru Ruthenium																	
45 Rh Rhodium																		46 Pd Palladium																	
47 Ag Silver																		48 Cd Cadmium																	
49 In Indium																		50 Sn Tin																	
51 Sb Antimony																		52 Te Tellurium																	
53 I Iodine																		54 Xe Xenon																	
55 Cs Cesium																		56 Ba Barium																	
57 La Lanthanum																		58 Ce Cerium																	
59 Pr Praseodymium																		60 Nd Neodymium																	
61 Pm Promethium																		62 Sm Samarium																	
63 Eu Europium																		64 Gd Gadolinium																	
65 Tb Terbium																		66 Dy Dysprosium																	
67 Ho Holmium																		68 Er Erbium																	
69 Tm Thulium																		70 Yb Ytterbium																	
71 Lu Lutetium																		72 Hf Hafnium																	
73 Ta Tantalum																		74 W Tungsten																	
75 Re Rhenium																		76 Os Osmium																	
77 Ir Iridium																		78 Pt Platinum																	
79 Au Gold																		80 Hg Mercury																	
81 Tl Thallium																		82 Pb Lead																	
83 Bi Bismuth																		84 Po Polonium																	
85 At Astatine																		86 Rn Radon																	
87 Fr Francium																		88 Ra Radium																	
89-103 Ac-Lu Actinide																		104 Rf Rutherfordium																	
105 Db Dubnium																		106 Sg Seaborgium																	
107 Bh Bohrium																		108 Hs Hassium																	
109 Mt Meitnerium																		110 Ds Darmstadtium																	
111 Rg Roentgenium																		112 Uub Ununbium																	
113 Uut Ununtrium																		114 Uuq Ununquadium																	
115 Uup Ununpentium																		116 Uuh Ununhexium																	
117 Uus Ununseptium																		118 Uuo Ununoctium																	
119 Ac Actinium																		120 Th Thorium																	
121 Pa Protactinium																		122 U Uranium																	
123 Np Neptunium																		124 Pu Plutonium																	
125 Am Americium																		126 Cm Curium																	
127 Bk Berkelium																		128 Cf Californium																	
129 Es Einsteinium																		130 Fm Fermium																	
131 Md Mendelevium																		132 No Nobelium																	
133 Lr Lawrencium																		134 Rg Roentgenium																	

Vision:

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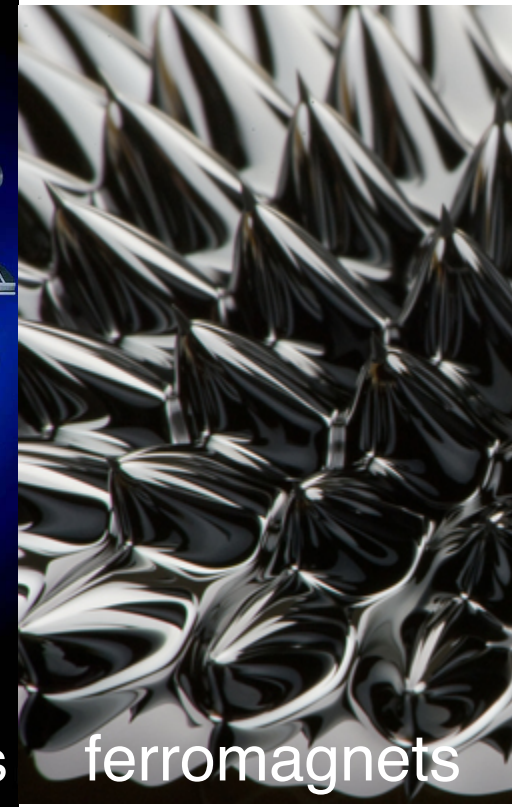
Impact:

New materials for energy storage & conversion (battery cathodes, nuclear reactor fuels, thermo-electrics), & with novel functionality for device applications (ferromagnets, ferroelectrics, etc).

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reactor fuels



ferromagnets