Synergetic Synthesis of Carbon-Carbon & Metal-Carbon Composites of Atomic Scale

Benjamin F. Dorfman, Presentation for Clarkson University. CAMP. 2005

New family of nanostructured ultra-light weight carbon based materials approaching the utmost physical limit of composite solid

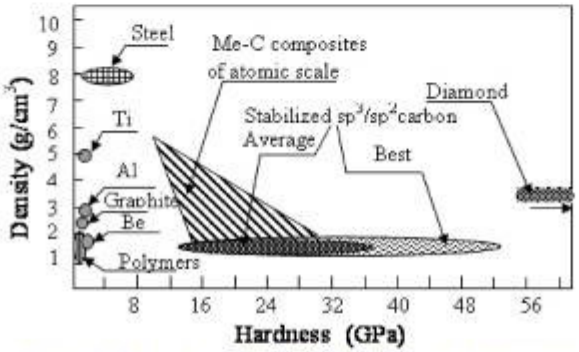


Figure 2: Density vs. Hardness for Stabilized Amorphous Carbon and other materials

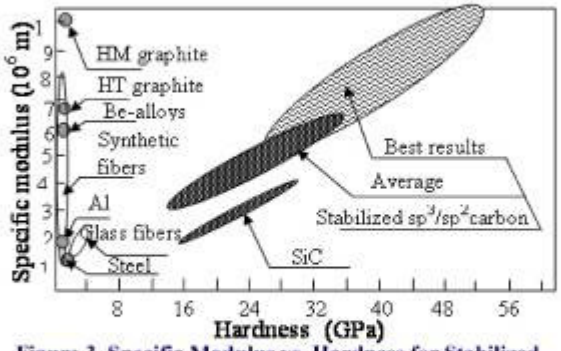
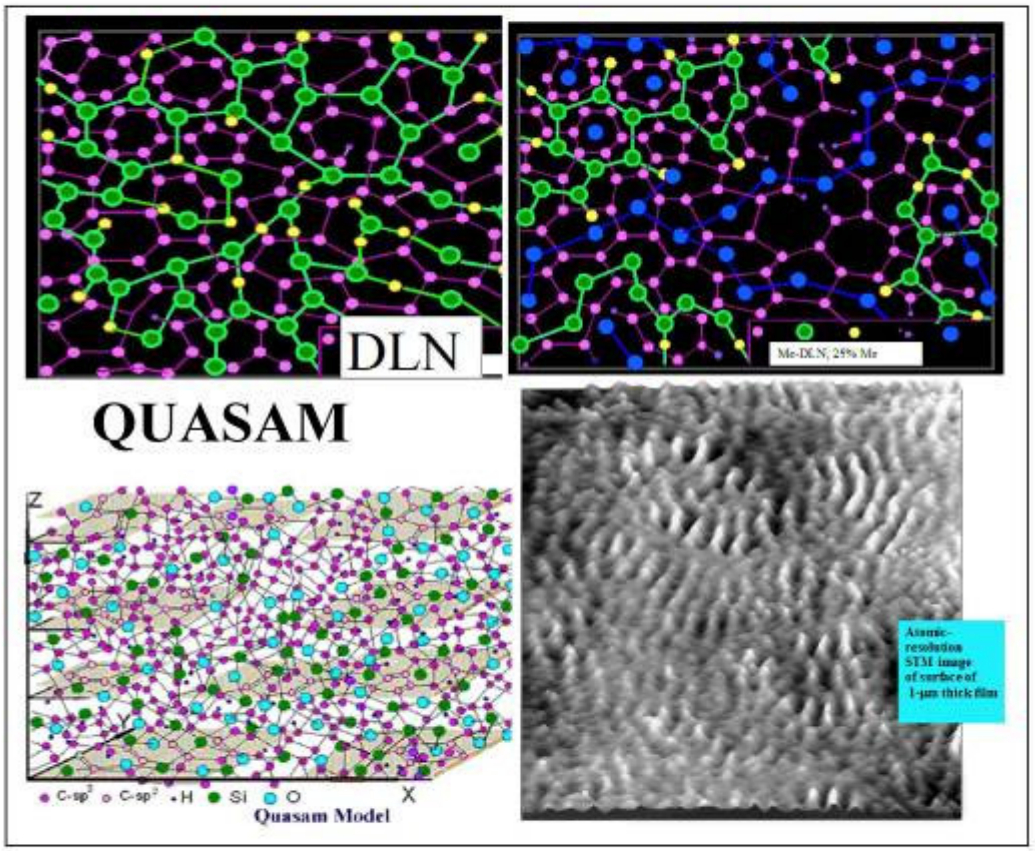


Figure 3. Specific Modulus vs. Hardness for Stabilized Amorphous Carbon and other materials

First in US and in the world patents on Nano-composites (from 1991, now –20).



Chemical stabilization shifts the graphite-diamond equilibrium. Silicon-stabilized and silica-stabilized sp^3: sp2 carbon solids **are virtually stress-independent**. long-term thermal stability 400-650°C, short-term thermal stability 550-950°C

NOW: multifunctional coatings: surface reinforcement, best tribology in any humidity & water, anti-icing, electric. tunable, capability for topographic stress monitoring sensors' system

Potentially – smart self-monitoring ultra-light weight construction material

ELECTRONIC PROPERTIES

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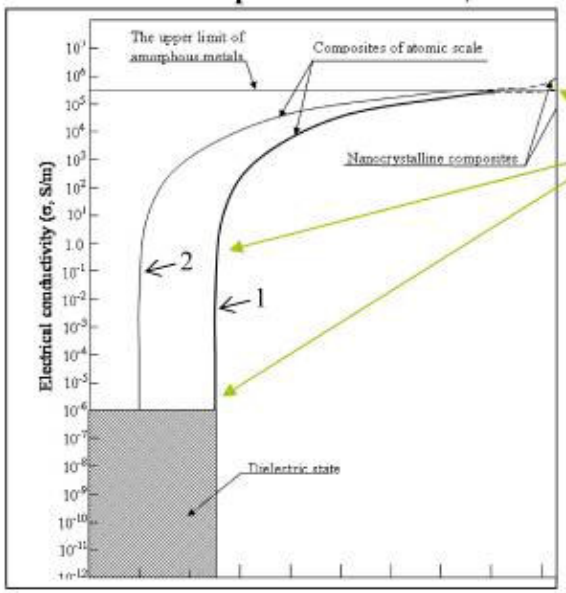
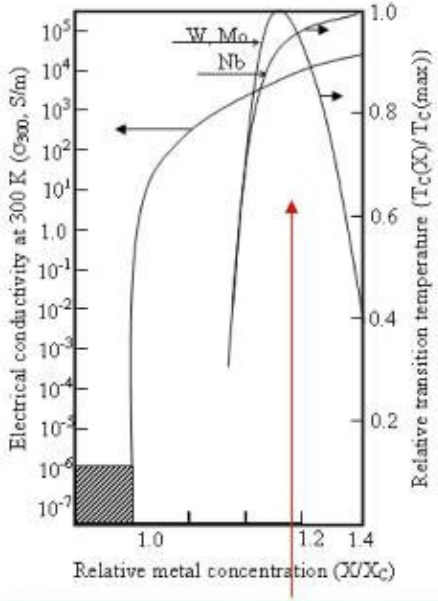
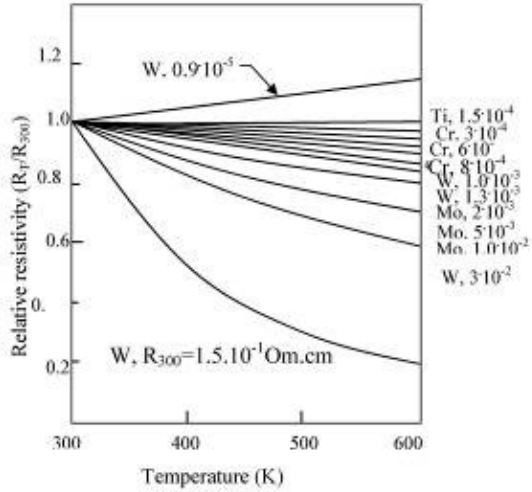
Atomic-Scale Composites (ASC) represent a new type of solid media allowing controllable variation of all the major electronic transport mechanisms, including low temperature superconductivity with extremely high critical magnetic field.



Electrical Conductivity of diamond-like Me-carbon ASCs versus the volume metal concentration for all examined metals.

1 – metals with small atomic radius (such as Ni, Co)
2 – metals with large atomic radius (such as Hf, Zr)





Optical properties of ASC may be varied in a relatively broad range as well. Thus, ASC are important electronic, micro-electro-mechanic and photonic materials.

Superconductivity transition temperature (Tc) vs metal concentration (X) near the percolation threshold (Xc). Two kinds of dependencies observed : monotonous (in {Nb|C}) and with maximum ({W|C} and {Mo|C}).

Resistivity of Me-DLN films vs. temperature in the range of 300– 600 K.
The room-temperature values of resistivity R300 are indicated for each plot. The proper metal-dielectric atomic scale composites possess negative temperature coefficient of resistivity

B.F. Dorfman, In: Handbook of Surfaces and Interfaces of Materials (H. S. Nalwa Ed.), v.1, Academic Press, San Diego, 447 (2001).