Reticulated Vitreous Carbon (RVC) as a Field Emission Surface for Large-Area Applications

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Glassy carbon foam has been demonstrated as a field emission material especially useful for large-area, high-current cathodes. This presentation explains the manufacturing techniques of this foam and examples of devices which use it as an emission material. An assessment of the advantages and weaknesses of this material in various applications will be presented.

Reticulated Vitreous Carbon (RVC) has been used as a lightweight structural material (aircraft wings, brake shoes, filter media, building construction, etc.) for over two decades [1]. RVC is made from pyrolized polymeric open-pore foam materials such as polypropylene or phenolic. Typically, after pyrolisis, the resulting carbon is 97% void, consisting of “struts” which are a mixture of SP3 and SP2 vitreous carbon. By varying the polymeric foam from which the RVC is made, it is possible to vary the porosity, conductivity, and density in the final material. Figure 1 shows a 0.5mm slice of cut (100 PPI) RVC. The cut struts form “tips” from which emission occurs. Nanoscopic investigation of the individual struts reveals considerable texture; therefore, this material produces countless random emission sites, making it ideal for high-current cathodes.

As an emission material, RVC behaves similar to carbon fibers. The surface is robust and self-regenerating: if current crowding develops, the sites exfoliate and new sites emerge. The carbon is less sensitive to chemical poisoning than metal or silicon tips. Emission persists at poor vacuum, although the noise figure increases and oxidation can occur at higher pressures. Cathodes at 10^{-6} Torr have been used to excite phosphors for 10,000 hours without visible degradation of the emission surface. Using 500 PPI foam, emission in simple diode-mode initiates at 1.7 V/micron. Unlike nanotip technology, however, it is impractical to use lithography or micromachining to make submicron devices; therefore, RVC is most useful for cathodes of approximately 50 microns or larger. 0.5mm disks of RVC have produced sustained 180 mA current.

Several applications are now being developed using RVC. Because the material is inexpensive and can be easily molded before pyrolosis, it is quite useful for use in lamps and pixel elements for large-area displays. It also has been successfully used as a cathode for x-ray tubes. The material can also be machined after it is pyrolized. Examples will be shown where large-format diode and triode devices have been made in this manner. It is also possible to pass inert gas through the open-pore RVC to create an ion stream.

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[1] J. Wang, *Electrochimica Acta*, **26**, 1721 (1981)

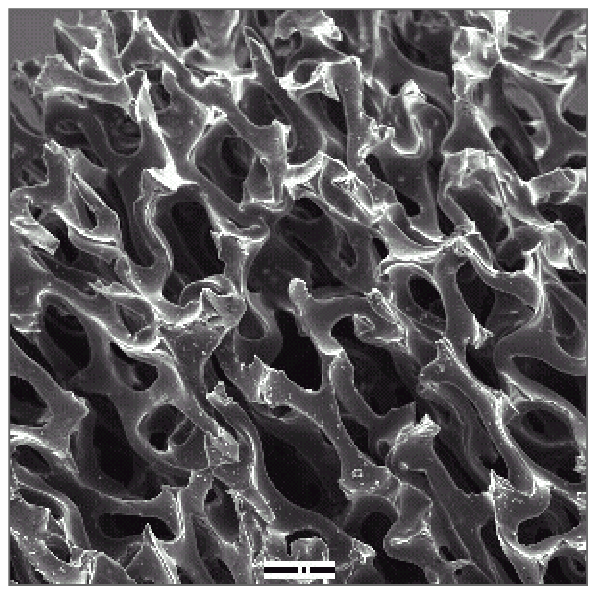

Figure 1: Cross-sectional view of cut RVC struts