

Comment on Fractal Aggregates in Sputter-Deposited Films

Recently Elam *et al.*¹ reported on the appearance of fractal-like structures in sputter-deposited NbGe₂ films. In the majority of such objects the structure was well developed with the outer limbs of the objects "thickened" with fractal dimension, $D \approx 1.9$. The underlying skeletal structure was observed to have a fractal dimension of about 1.7. The purpose of this Comment is to report on the existence of similar structures observed after sputtering Au under dramatically different conditions.

As in the work of Ref. 1, our structures were created quite by accident. We are engaged in studies with ⁴He films. Our present substrates are Nuclepore filter material (polycarbonate, 0.2- μ m-diam pores), and to characterize the surface structure scanning-electron-microscope (SEM) images are made. As a preliminary step, Au is sputtered onto the Nuclepore. Under some conditions structures such as those shown in Fig. 1 appear. The actual conditions necessary for the growth of these structures are obscure; the growth is not reproducible and may be due to a contaminant. The Au is sputtered with 2.2 kV rf in an Ar atmosphere of 0.01–0.1 Torr with the substrate at $T \approx 40^\circ\text{C}$. For the case of Fig. 1 the underlying skeletal structure is digitized and we observe $D = 1.63$ and the object as observed and digitized with full limbs has $D = 1.80$.

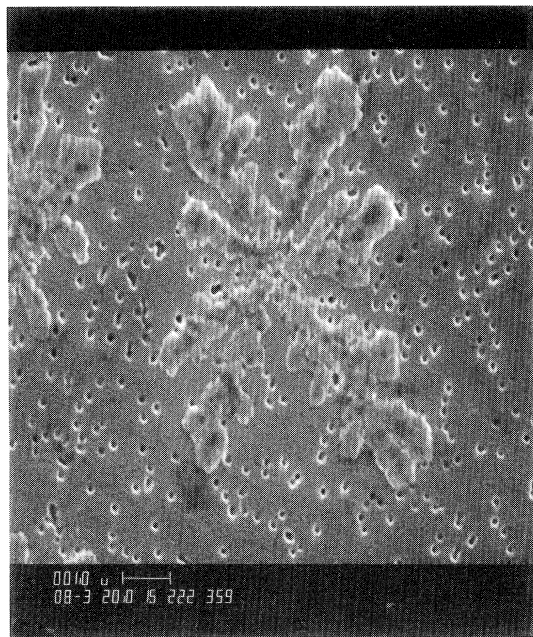


FIG. 1. SEM photograph of a Nuclepore filter substrate which shows a fractal aggregate. The maximum dimension across the object is 10 μ m.

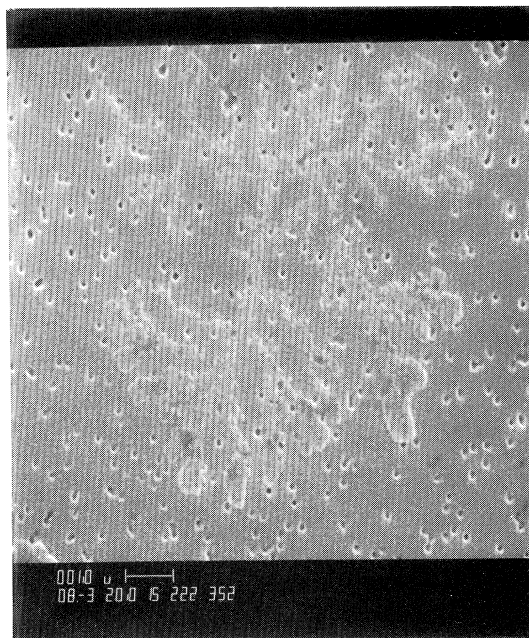


FIG. 2. Fractal aggregate structure which shows a dramatic change in properties within the single object.

These numbers are typical. Although our structures are about a factor of one hundred smaller than those shown in Ref. 1, the limb thickening is apparent and often quite complete.

At present we are exploring the growth process and there is evidence that the character of the structures can be changed dramatically. Figure 2 shows a single object which displays several characteristics generally observed in isolation; it shows thin filamentary structure over a substantial part of its area (with the filaments apparently made up of tiny "islands" of characteristic size 500 \AA) and it shows lobed structure primarily on one side. Presumably a gradient in the growth conditions resulted in this appearance. The fractal dimension of such structures may be continuously variable over a substantial range.

D. T. Smith

J. M. Valles, Jr.

R. B. Hallock

Laboratory for Low Temperature Physics
Department of Physics and Astronomy
University of Massachusetts
Amherst, Massachusetts 01003

Received 28 March 1985

PACS numbers: 68.55.+b, 06.30.Bp, 68.70.+w, 81.15.Cd

¹W. T. Elam, S. A. Wolf, J. Sprague, D. V. Gubser, D. Van Vechten, G. L. Barz, Jr., and P. Meakin, *Phys. Rev. Lett.* **54**, 701 (1985).

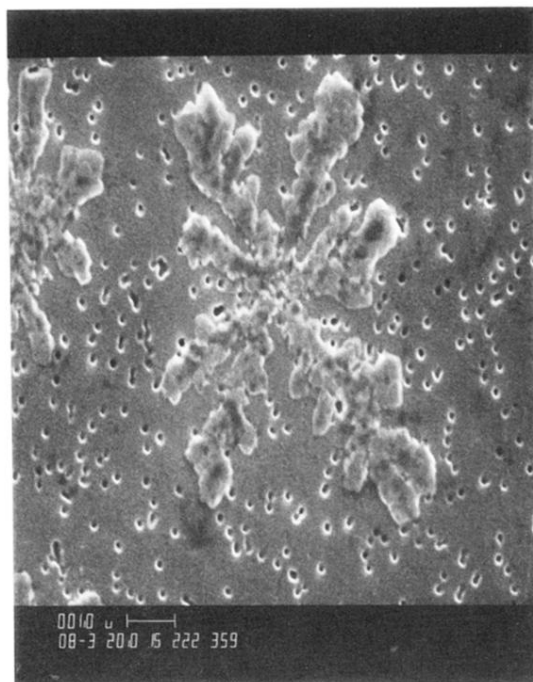


FIG. 1. SEM photograph of a Nuclepore filter substrate which shows a fractal aggregate. The maximum dimension across the object is $10\ \mu\text{m}$.

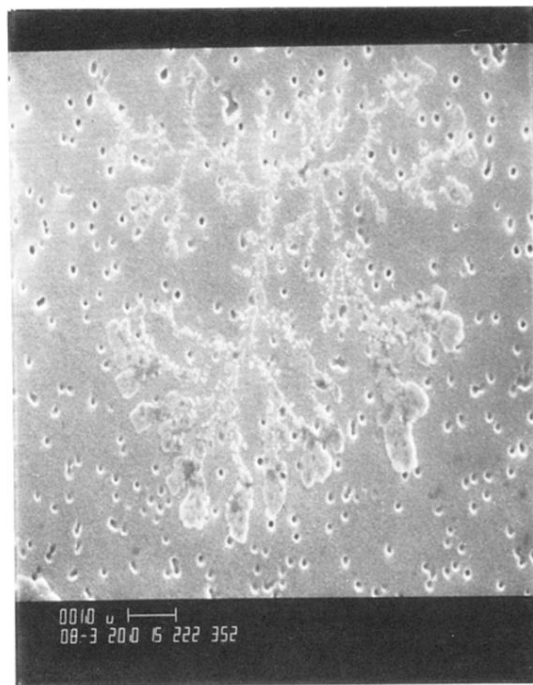


FIG. 2. Fractal aggregate structure which shows a dramatic change in properties within the single object.