CC/NUMBER 7
FEBRUARY 18, 1980

This Week's Citation Classic

Barber D J. Thin foils of non-metals made for electron microscopy by sputter-etching. *J. Mater. Sci.* 5:1-8, 1970. [Dept. Physics, Univ. Essex, Colchester, UK]

The paper reviews established methods for making thin foils of non-conductors and describes their inadequacies. The design and operating conditions of an apparatus for preparing thin foils by sputteretching (ion-thinning) is then discussed. The new method is shown to be widely applicable, with examples of thinned ceramics, glasses, and minerals. [The *SCI*® indicates that this paper has been cited over 100 times since 1970.]

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January 2, 1980

"When I took up a lectureship at a new British university in 1965 I intended to change my research field. I soon realized, however, that it was difficult to do this from a completely unestablished base. Instead, I decided to pursue an idea which had excited me towards the end of my previous appointment. At the National Bureau of Standards (NBS) in Washington I had been studying oxides by transmission electron microscopy (TEM) with a colleague, Nancy Tighe, but we lacked a universal method for making polycrys-talline specimens thin enough to transmit electrons. Through a chance meeting with M. Paulus we learned that he had thinned ferrites by ion bombardment,[1,2] and we became convinced that the method could be widely applied. As a result, NBS took delivery of a machine, built to the Paulus design, in 1966. Nancy Tighe wrote to me that initially there were problems with the apparatus.[3] This news, coupled with my very limited funding, led me to build my own equipment from scratch — a decision which influenced the whole of my subsequent research.

The first version, constructed in the workshop of the new physics department of the University of Essex, was operational in early 1967.

"Soon I was torn between the desire to improve the equipment, my wish to exploit the new method and apply TEM to hitherto inaccessible problems, and demands from fellow scientists to prepare thin foils for them. Invitations to speak about the technique and research contracts on ion/solid interactions followed, and I made many fruitful contacts with materials scientists and geologists. Initially, however, the British ceramics industry seemed luke-warm, and I was even rebuked by the technical director of one organization, who could see little use for the new technique! Nonetheless, commercially manufactured ion-thinners are now found in a wide variety of laboratories.

"The highly cited paper is based upon a talk I gave in Oxford in 1968 and a report which I was asked to write about the equipment by a government trade department (who then declined to publish it). Eventually the many enquiries about the technique convinced me that it was worth writing a descriptive paper, without excessive technical detail. I believe that the paper has been widely cited because it demonstrates the applicability of ion-thinning to a range of materials and it discusses operating parameters.

"The interesting lesson, to me, is that Paulus's work and that of Castaing[4] and other French workers in the 1950s was 'ahead of its time.' Ion bombardment proved to be inferior to electro-polishing for preparing metal specimens, and the other possibilities were not yet ripe for exploitation. The literature was largely forgotten and ignored for several years. Now ion beams play an increasingly important role in materials and solid state science."

1. **Paulus M & Reverchon F.** Dispositif de bombardement ionique pour preparations micrographiques. *J. Phys. Radium* **22**:103-7A. 1961.
2. **Paulus M & Reverchon F.** Etude des parametres du bombardement ionique des ferrites. (Trillat J J. ed.) *he bombardement ionique.* Bellevue, France: CNRS, 1962. p. 223-34.
3. **Tighe N J.** Microstructure of fine-grain ceramics. (Burke J J, Reed N L & Volker W, eds.) *Ultrafine-grain ceramics.* Syracuse: Syracuse University Press, 1970. p. 249-58.
4. **Castaing R & Laborie P.** Examen direct des metaux par transmission au microscopie electronique. *C. R. Acad. Sci. Paris* **237**:1330-2, 1953.