further clarification is particularly important because of the implications for the use of superconducting cables and vacuum insulation.

W. T. WILLIAMS

*Department of Physics,
University College of Swansea,
Singleton Park,
Swansea*

Received March 19; revised April 23, 1971.

- ¹ Dyke, W. P., and Trolan, J. K., *Phys. Rev.*, **89**, 799 (1953).
- ² Morgan, C. Grey, *Handbook of Vacuum Physics* (Pergamon, Oxford, 1965).
- ³ Alpert, D., Lee, D. A., Lyman, E. M., and Tomaschke, H. E., *J. Vac. Sci. Tech.*, **1**, 35 (1964).
- ⁴ Gomer, R., and Hulm, J. K., *J. Chem. Phys.*, **20**, 1500 (1952).
- ⁵ Looms, J. S. T., Meats, R. J., and Swift, D. A., *J. Phys. D*, **1**, 377 (1968).
- ⁶ Klein, R., and Leder, L. B., *Phys. Rev.*, **124**, 1050 (1961).
- ⁷ Fowler, R. H., and Nordheim, L., *Proc. Roy. Soc., A*, **119**, 173 (1928).
- ⁸ Good, R. H., and Müller, E. W., *Hand. der Phys.*, **22** (Springer, Berlin, 1956).
- ⁹ Williams, D. W., and Williams, W. T., *Proc. Ninth Intern. Conf. Ionization and Gas Discharges*, 87 (Bucharest, 1969).

Glass Ceramic Material based on Abu-Zaabal Basaltic Rocks

NATURAL rocks, especially basic volcanic varieties, have been widely used for the production of melt-cast ceramic materials of good mechanical and thermal properties and of high chemical and abrasion resistance. Systematic studies of the processes of melting and recrystallization of some Egyptian basaltic rocks and basalt-based melts and glasses have been carried out to discover the most favourable conditions for the production of cheap silicate materials. A large number of basalt-based melts and glasses, in which the basaltic composition was adjusted by several additions of CaCO_3 , MgCO_3 , and quartz sand (sometimes with small amounts of Cr_2O_3 and CaF_2 as crystallization catalysts), was studied with the view to the production of high quality glass ceramic materials.

Different schedules of heat treatment were tested in a search for the optimum conditions for nucleation and crystallization, for the formation of the desired texture and mineralogical constitution. Optical, chemical, and X-ray methods were also used.

A new glass ceramic material has recently been produced at the National Research Centre, Egypt, based on Abu-Zaabal basaltic rocks. This material has the following chemical composition (in percentages by weight): 47.14 SiO_2 , 2.36 TiO_2 , 9.95 Al_2O_3 , 5.75 Fe_2O_3 , 2.22 FeO , 12.13 MgO , 18.30 CaO , 1.66 Na_2O , 0.49 K_2O (+0.5 g Cr_2O_3).

The optimum schedule of heat treatment for crystallization comprises the gradual heating of the annealed glass up to 900° C, the maintenance of the sample at this temperature for two hours, and then the raising of the temperature up to 1,050° C for three hours followed by cooling at a relatively higher speed. Treated in this way, the glass gives a compact, flint-like, brownish grey, almost holocrystalline mass, with a very fine-grained texture composed largely of pyroxene (augite). The grains are generally less than 1 μm in size, very rarely reaching 1.5 μm (Fig. 1).

The most valuable feature of the resultant glass ceramic material is its excellent resistance to abrasion and chemical

Fig. 1 Pyroxene crystals forming very fine-grained uniform texture. (Nicols+, $\times 1,000$.)

attack. The chemical durability of the resultant melt-cast crystalline product is about five times that of the original basaltic rock. The diamond pyramid hardness (DPH) number, determined for this material under a load of 1 kg, reaches 822. The material also has a scratch hardness of about 8.5 according to Moh's hardness scale.

A. A. OMAR
A. W. A. EL-SHENNAWI

*National Research Centre,
Cairo*

Received March 26, 1971.

Editorial and Publishing Offices of NATURE

MACMILLAN JOURNALS LIMITED
4 LITTLE ESSEX STREET, LONDON WC2R 3LF
Telephone Number: 01-836 6633. Telegrams: Phusis London WC2R 3LF

711 NATIONAL PRESS BUILDING
WASHINGTON DC 20004
Telephone Number: 202-737 2355

Subscription Department
MACMILLAN JOURNALS LIMITED
BRUNEL ROAD, BASINGSTOKE, HANTS
Telephone Number: Basingstoke 5431

Advertisements only should be addressed to
T. G. SCOTT & SON, LIMITED
1 CLEMENT'S INN LONDON WC2A 2ED
Telephone 01-242 6264/01-405 4743
Telegrams: Textualist London WC2A 2ED

Registered as a newspaper at the Post Office

Copyright © Macmillan Journals Limited, May 10 1971