

Fig. 4. Charge-pressure cycle  $\text{PbZr}_{0.95}\text{Ti}_{0.05}\text{O}_3 + 0.8\% \text{WO}_3$ ,  $r$  poled at room temperature,  $h$  poled when hot

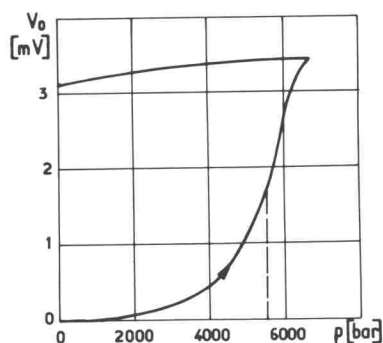


Fig. 6. "Charge-pressure" cycle for  $\text{PbZr}_{0.92}\text{Ti}_{0.08} + 0.8\% \text{WO}_3$

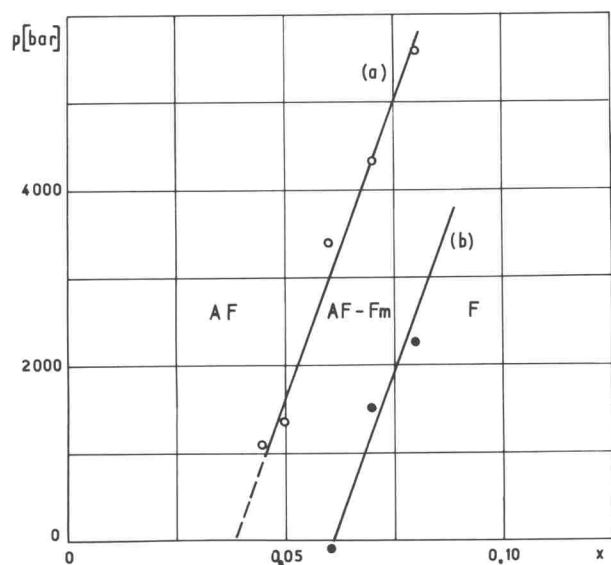


Fig. 5. "Pressure-composition" phase diagram  $a$  increasing pressure,  $b$  decreasing pressure

## 2. Experimental Results

### Depolarization of the Short-Circuited Specimens

The curves  $r$  and  $h$  plotted in Fig. 4 show the variation of the "charge pressure" cycles for  $x = 0.05$  after polarization of the ceramic when cold and hot, respectively.

This composition is antiferroelectric at room temperature. It becomes metastable ferroelectric ( $Fm$ ), however, if an electric field is applied [5]. Both the low value of the transition pressure and the poor polarizability of the specimen when cold can be explained by the metastable phase. The transition pressure is defined as the abscissa value of the point

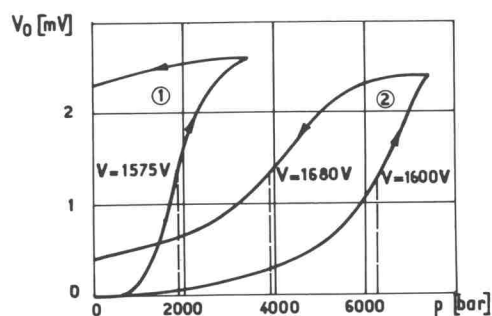


Fig. 7. "Charge pressure-cycle" ( $C_1 = 1085 \text{ pF}$ ,  $C_0 = 1300 \text{ } \mu\text{F}$ ) for 1  $\text{PbZr}_{0.95}\text{Ti}_{0.05}\text{O}_3 + 0.8\% \text{WO}_3$  and 2  $\text{PbZr}_{0.92}\text{Ti}_{0.08} + 0.8\% \text{WO}_3$

of the curve whose ordinate value is the half of the charges liberated during the transition process. Preference has, therefore, to be given to the polarization of the specimen when hot, because the  $F \rightarrow AF$  pressure enforced transition is more pronounced and the loss of polarization is increased (approaching the remanent polarization of the material). Analogous results are achieved with compositions of the  $x > 0.06$  type for samples polarized when hot or cold. From Fig. 5a and 6 it can be seen that the transition pressure increases rapidly with increasing titanium contents, whereas the charges are liberated in a somewhat less pronounced manner.

### Depolarization on Capacitive Loads

In the case of decreasing load capacities, the electric field increases more and more rapidly with the liberated charge. Curve 1 of Fig. 7 illustrates a "charge pressure" cycle for an antiferroelectric composition at room temperature. The transition process occurs over a larger pressure range and the value of the

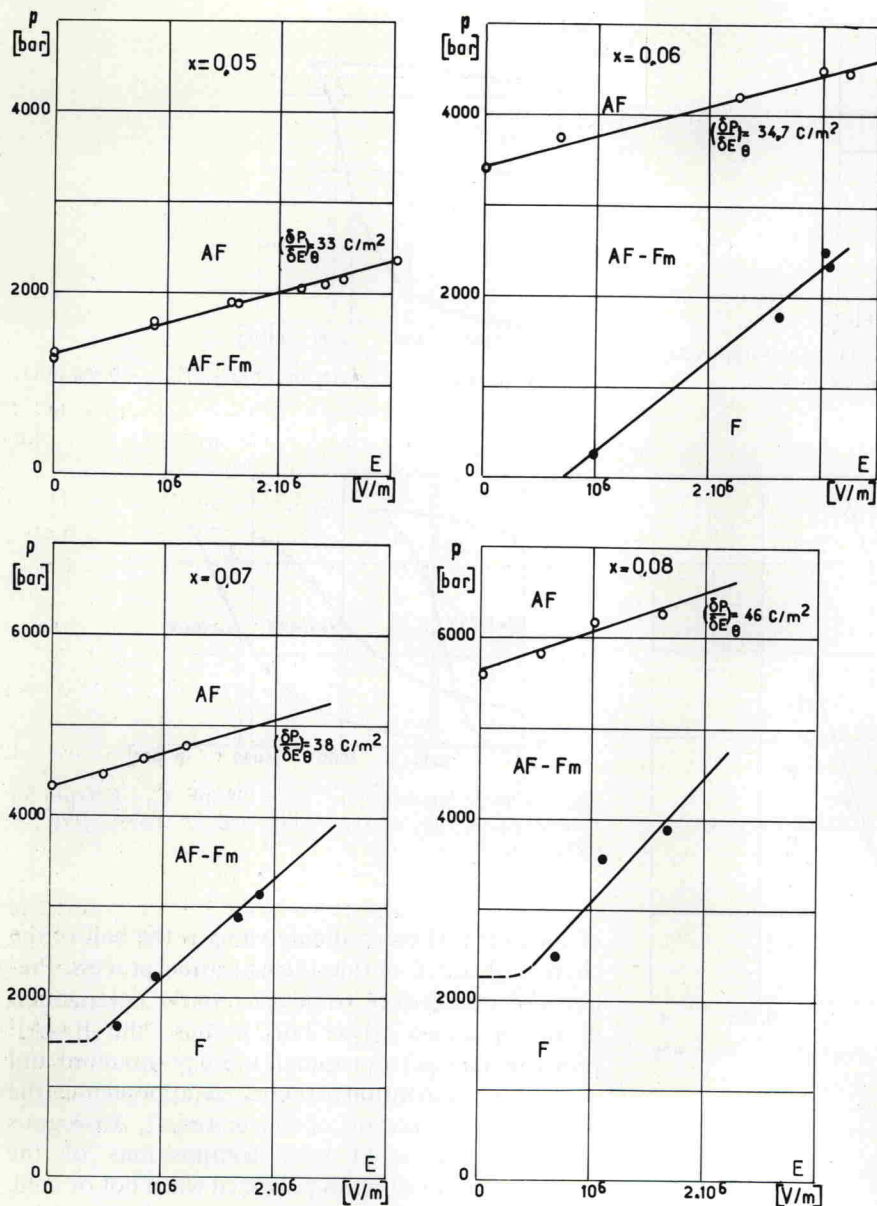


Fig. 8. "Pressure-electric field" phase diagram for various composition (○: increasing pressure, and ●: decreasing pressure)

transition pressure, as defined above, is increased. Finally, a slight repolarization can be observed in the decompression process for strong electric fields. For ferroelectric compositions at room temperature, the AF→F transition results in a very marked repolarization of the ceramic (Curve 2, Fig. 7). This repolarization is stopped, however, when the value of the electric field falls below that of the coercive field. The transition pressure AF→F in the decompression phase is defined as the abscissa value of that

point of the curve whose ordinate is the half the charges recovered by the ceramic.

The electric field corresponding to each transition pressure is given by

$$E = \frac{V}{s} \quad \text{and} \quad V = V_0 \frac{C_0}{C_1},$$

where  $s$  is the thickness of the specimen. In changing the values of the load capacity, it is possible to plot the phase diagram (Fig. 8) "transition pressure electric