# Predetonation conductivity of silver azide

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The conductivity of silver azide whiskers detonated by a laser pulse was measured. It was shown that the conductivity pulse leads the detonation by 50–70 ns and that the sample approaches metallic conductivity. It was concluded that the explosion occurs by a chain mechanism. © *1995 American Institute of Physics.*

The mechanism of the explosive decomposition of $AgN_3$ itself is still unclear despite the fact that for many years silver azide has been a model object for investigation of initiating explosives. It is generally assumed that the explosive decomposition is a consequence of the exothermal reaction $2N_3^0 \rightarrow 3N_2$, which causes an energy of 10–12 eV to be released.[1] However, the question of which detonation mechanism — thermal or chain — is realized in silver halide has remained unclear.[1,2]

We report here the results of experimental studies in which the predetonation conductivity of silver azide was observed for the first time. These results, in our view, allow us to conclude unambiguously that the explosion occurs through the chain mechanism.

The conductivity of silver azide whiskers in the process of explosive decomposition initiated by a neodymium laser pulse (1060 nm, 30 ps, 3–20 mJ) was investigated. Two series of experiments were performed. In the first series the sample was secured between electrodes in air. Voltage was applied through indium–gallium contacts (3–100 V). The current through the sample and the luminescence were measured simultaneously (FÉU-97 photomultiplier, UFS-1 filter). In the second series the sample was secured to a dielectric plate which was in contact with the sensitive element of an acoustic pickup whose temporal resolution was $\leqslant 10$ ns. The current through the sample, the luminescence, and the acoustic signal were measured simultaneously. The presence of a substrate in the second series of experiments distorted the trailing edge of the conductivity and luminescence pulses but had no effect on the leading edge. This made it possible to fix accurately the time of all three signals investigated. The response of the system to the initiating laser pulse was used as a reference which made it possible to fix the signal times: the leading edge of the current pulse from a silicon resistance inserted instead of the sample in the case of the conductivity, the photomultiplier pulse from the scattered laser light in the case of the luminescence, and the pressure pulse from the laser pulse in the case of the acoustic signal. Figure 1 shows oscillograms matched in this manner for one of the experimental samples. The rather long "dead" time preceding the detonation, which varies between 800 and 20 ns as the energy of the initiating pulse increases from 3 to 20 mJ, is worth noting. The leading edge of the conductivity pulse in this case does not change in the process. The luminescence of the sample is observed during the "dead" time and on the leading edge of the conductivity pulse. The luminescence peak is also

  

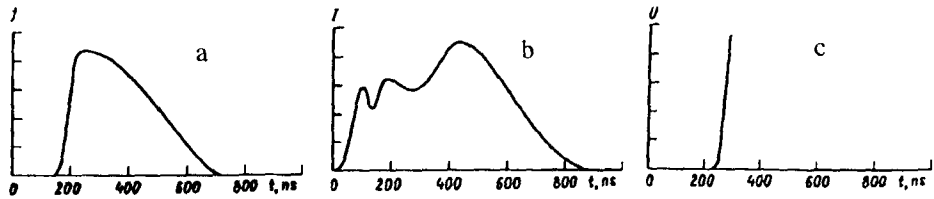


FIG. 1. Current (a), luminescence (b), and acoustic (c) signals from a silver azide whisker in the process of decomposition initiated by a laser pulse. The time is measured from the response of the system which records the signals to the initiation pulse. The units of the signals ( $j$, $I$, $U$) are arbitrary.

observed on the trailing edge of the conductivity pulse, which corresponds to the detonation of the sample. This last luminescence peak is apparently due to the plasma formed in the explosion.

The following two circumstances are most interesting.

1. The leading edge of the conductivity pulse leads by 50–70 ns the acoustic signal, whose leading edge is coincident with the maximum of the current pulse. Since the leading edge of the acoustic signal corresponds to destruction of the sample, the rising part of the current pulse is due to the conductivity of the intact crystal, i.e., it can be confidently identified as the predetonation conductivity. The last drop in the conductivity is due to the destruction of the sample.

2. Measurement of the predetonation conductivity in crystals with different cross sections showed that the predetonation current is determined by the resistance of the contacts. This makes it possible to estimate the lower limit of the predetonation conductivity of the crystal as $\geqslant 10^3$ S/cm; i.e., in the predetonation regime the conductivity of the sample approaches metallic conductivity. This fact indicates unequivocally that the reaction is of a nonthermal character, giving rise to multiplication of electronic excitations and ultimately leading to detonation of the sample. Indeed, simple estimates show that for a thermal band gap in silver azide $\sim 1.5$ eV (Ref. 3), the observed values of the conductivity correspond to sample temperatures of the order of several thousand degrees, which is completely unrealistic.

The nature of the predetonation state is also, in our view, of fundamental interest. In this state the geometric dimensions of the sample do not yet change substantially (there is no acoustic signal) and the conductivity approaches metallic conductivity.

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