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# Studying of initial stage of wire explosion by x-ray radiography using X pinch as a source.

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Wire array experiments where wire basic mass conserved the initial location instead of a cylindrical shell posed the problem of a so-called "cold start" of discharge. Energy deposition into the wire during initial stage of the discharge in vacuum is usually limited by breakdown between electrodes along the wire surface. A wire explosion in a gaseous and condensed media prevents early breakdown and extends possibilities of study of phase transitions of the wire material. In the present work we studied the influence of the external media on the explosion of micron-size wires by a nanosecond discharge. The aluminum, copper, nickel and tungsten wires of the diameter $d$ = 10-50 μm were exploded in open air, plasticine, epoxy, water and oil by the current pulse with the growth rate of ~ $10^{11}$ A $s^{-1}$. A generator based on a low-inductance capacitor, the discharge voltage being 20 kV, produced the current pulse with the amplitude up to 10 kA. Electrical parameters of the discharge were measured, and resistance of wire and energy deposition versus time were determined

We discuss the results on obtaining the wire explosion images in gaseous and liquid media with the help of hard X-ray radiation (in 10-20 ns pulse) of an X-pinch in the BIN facility diode (270 kA, 150 ns; P.N.Lebedev Institute). Exploded wires were placed outside the BIN vacuum chamber and images were registered on the film without magnification. Spatial resolution was limited by film grain structure, and reached 20-30 μm. Spectral range of the imaging radiation (15-30 keV) was determined by vacuum chamber window material, film sensitivity and thickness of the media where wire was exploded.

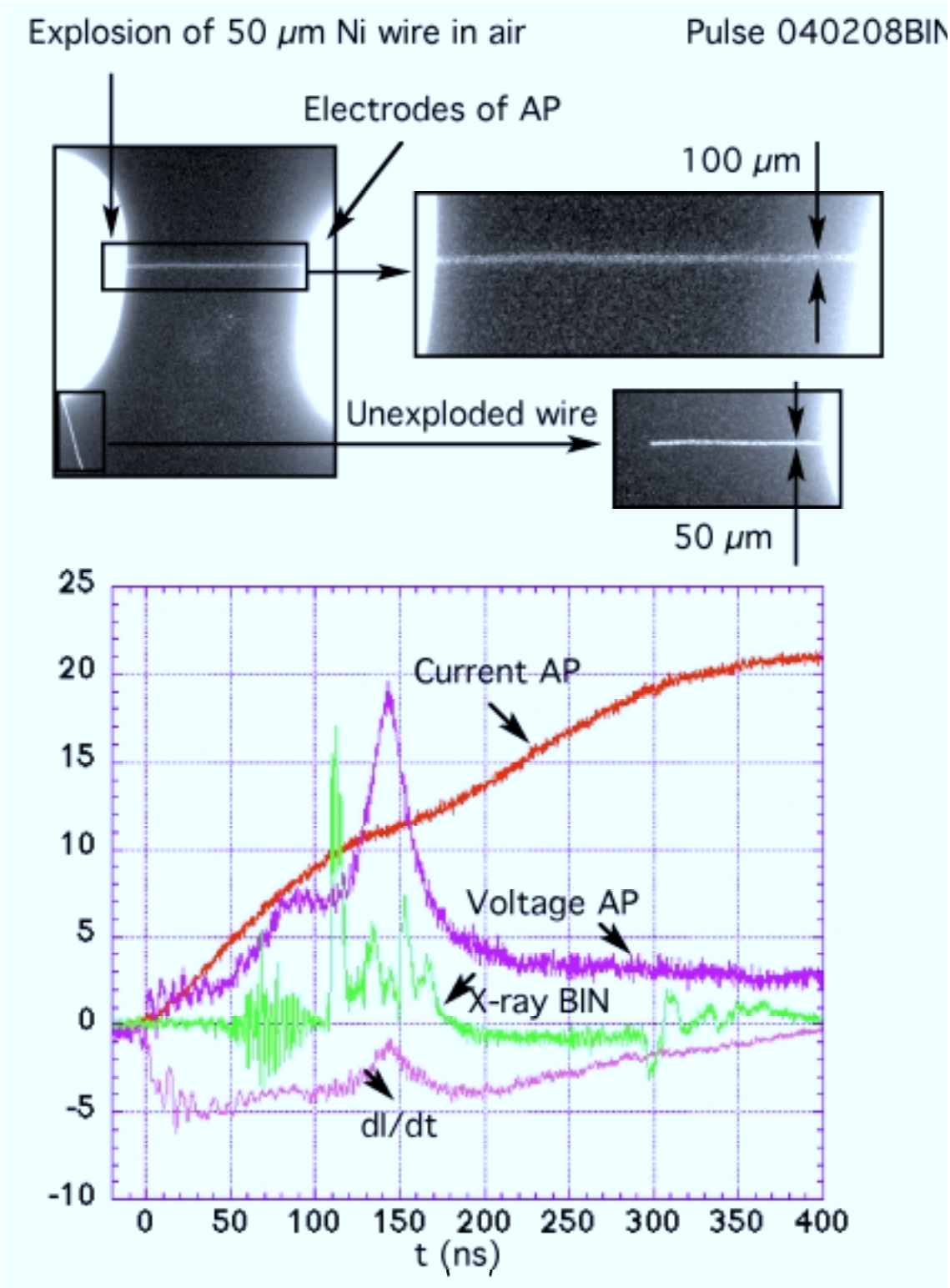


Fig. 1. X-ray radiograph of 50 μm Ni wire in open air and current, voltage, dI/dt and X-ray signals (arbitrary units).

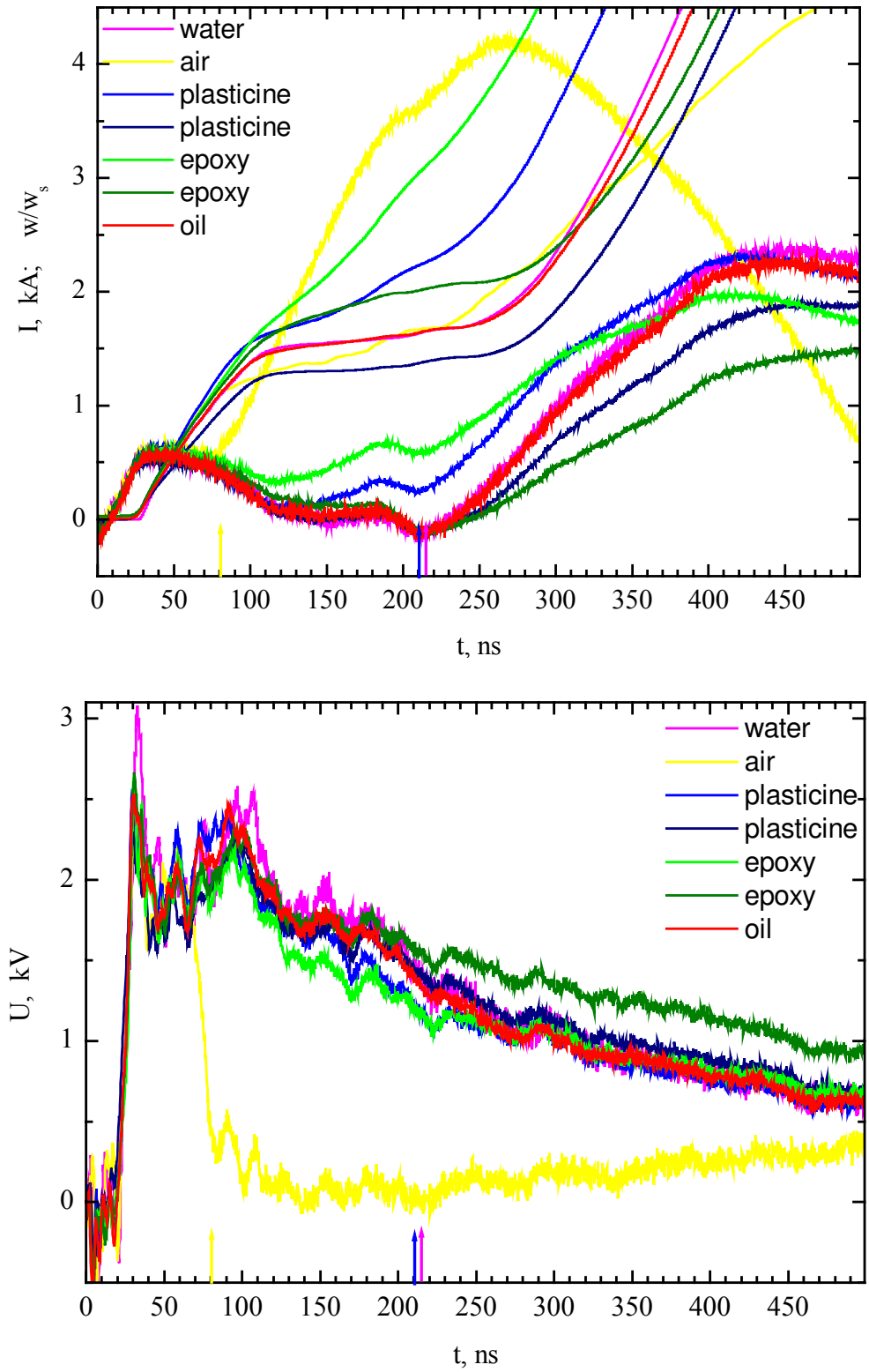


Fig.2. The deposited energy, heating current and voltage at the explosion of 25 μm tungsten wires ($l$ = 12 mm, $L$ = 570 nH) submerged into different media. $w_s$ – sublimation energy. Arrows denote the moment of breakdown.

Table. Parameters at electrical explosion of tungsten wire. $w_{ph}$, $U_{ph}$, $I_{ph}$, $R_{ph}$ – deposited energy, voltage, current and resistance at the moment of phase explosion, $w_d$, $U_d$, $I_d$, $R_d$ – deposited energy, voltage, current and resistance at the moment of breakdown.

| 25 μm tungsten wires | | | | | |
|---|---|---|---|---|---|
| media | plasticine | epoxy | oil | water | air |
| $w_{ph}/w_s$ | 1.28±0.09 | 1.4±0.1 | 1.18±0.03 | 1.35±0.16 | 0.73±0.01 |
| $U_{ph}$, V | 22235±650 | 20750±250 | 21446±744 | 22466±766 | 21476±474 |
| $I_{ph}$, A | 370±55 | 409±8 | 391±32 | 396±25 | 586±23 |
| $R_{ph}$, Ω | 55±1 | 53±4 | 55±7 | 57±6 | 32±4 |
| $w_d/w_s$ | 1.95±0.18 | 2.23±0.19 | 1.81±0.08 | 1.99±0.17 | 1.18±0.04 |
| $I_d$, A | 257±16 | 316±21 | 230±29 | 157±89 | 625±19 |
| $U_d$, V | 13105±1260 | 14360±980 | 11381±221 | 12992±1619 | 3079±509 |
| $R_d$, Ω | 51±1 | 46±2 | 50±6 | 54±10 | 4.9±0.9 |

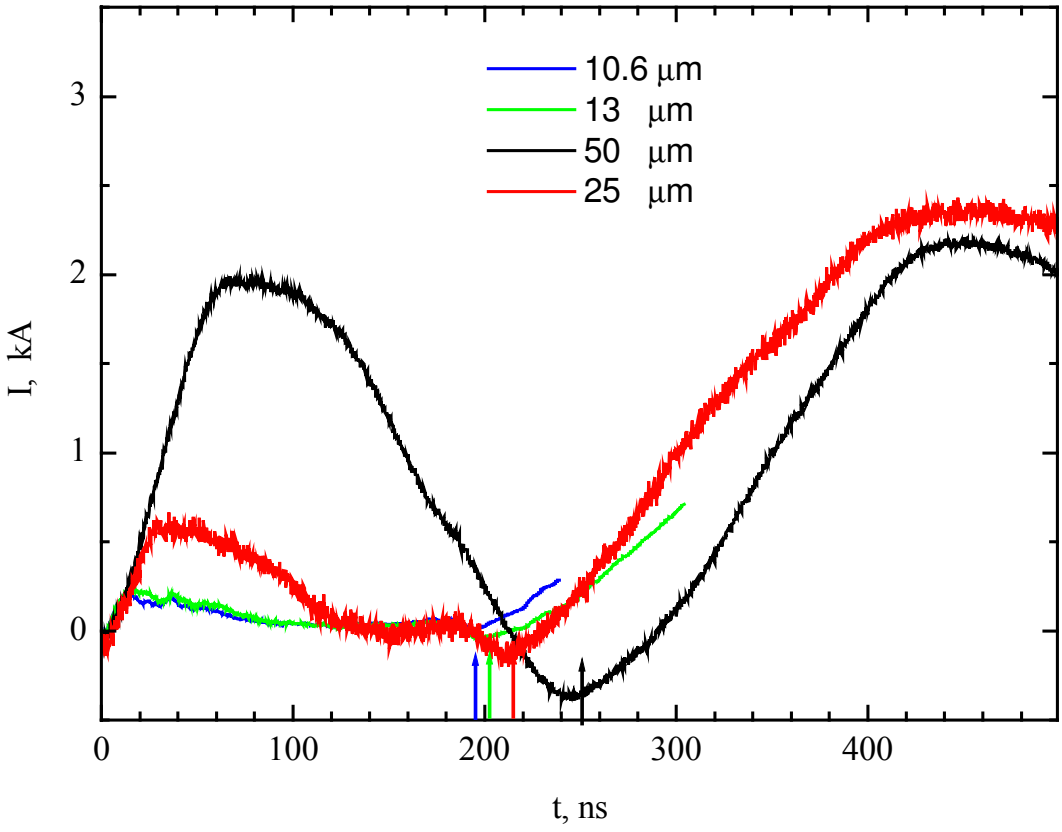


Fig.3. The current at the explosion of tungsten wires ($l$ = 12 mm, $L$ = 570 nH) submerged into water. Arrows denote the moment of breakdown.

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