CHAPTER 3
RESULTES AND DISCUSSION

PART I
RESULTES

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Results and discussion

Part 1

Results

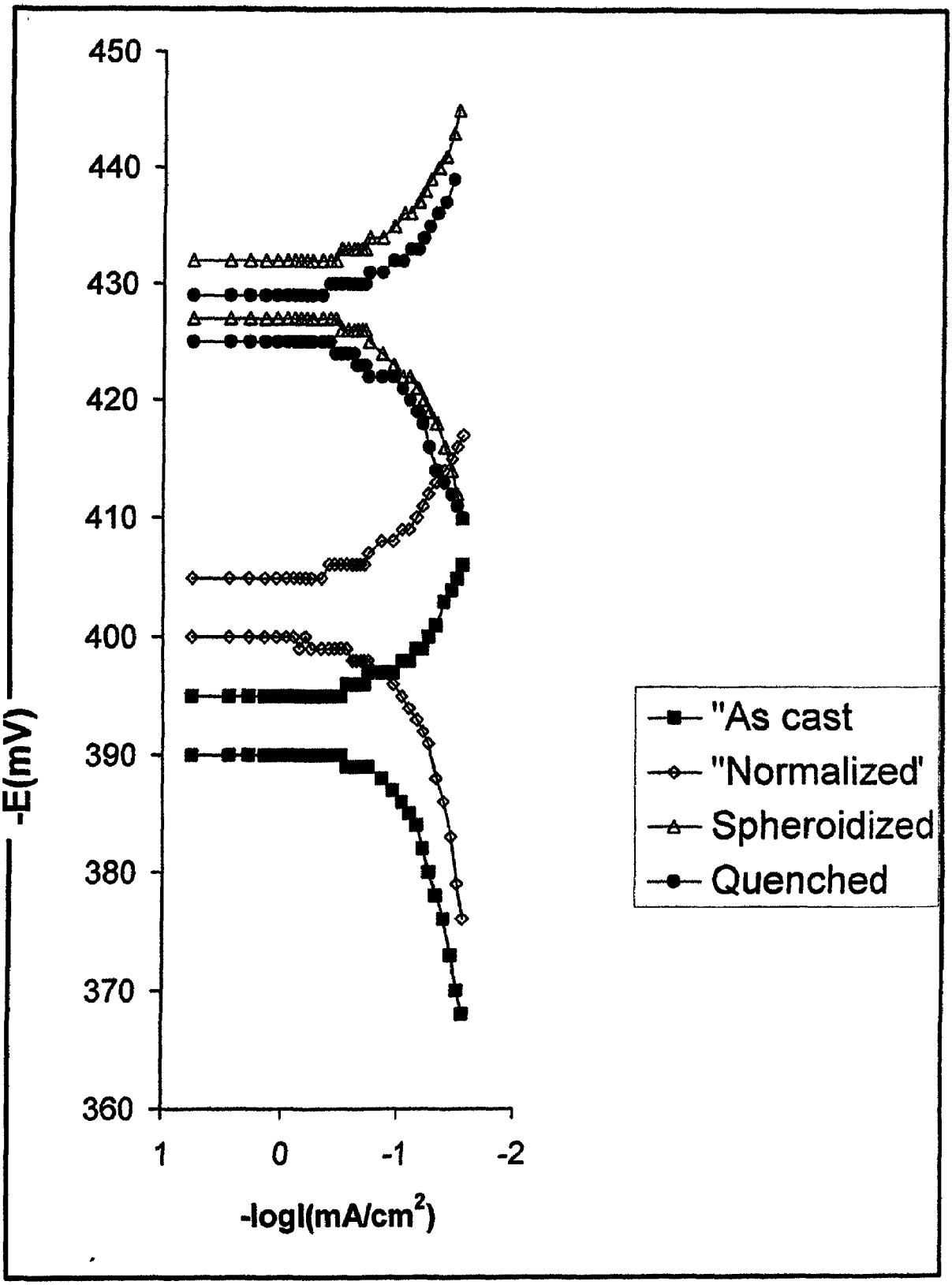
In this part, the experimental data of polarization technique were treated mathematically using Tafel equation, to deduce the corrosion resistance values for two types of C.V.steel (L&M) as its and after heat treatment in different corrosion media (0.1, 0.3 and 0.5 M HNO_3) at different temperatures. Also, effect of HEAA, as inhibitor in the corrosion processes of different samples under study was studied and discussed.

A) Data treatment for the polarization technique

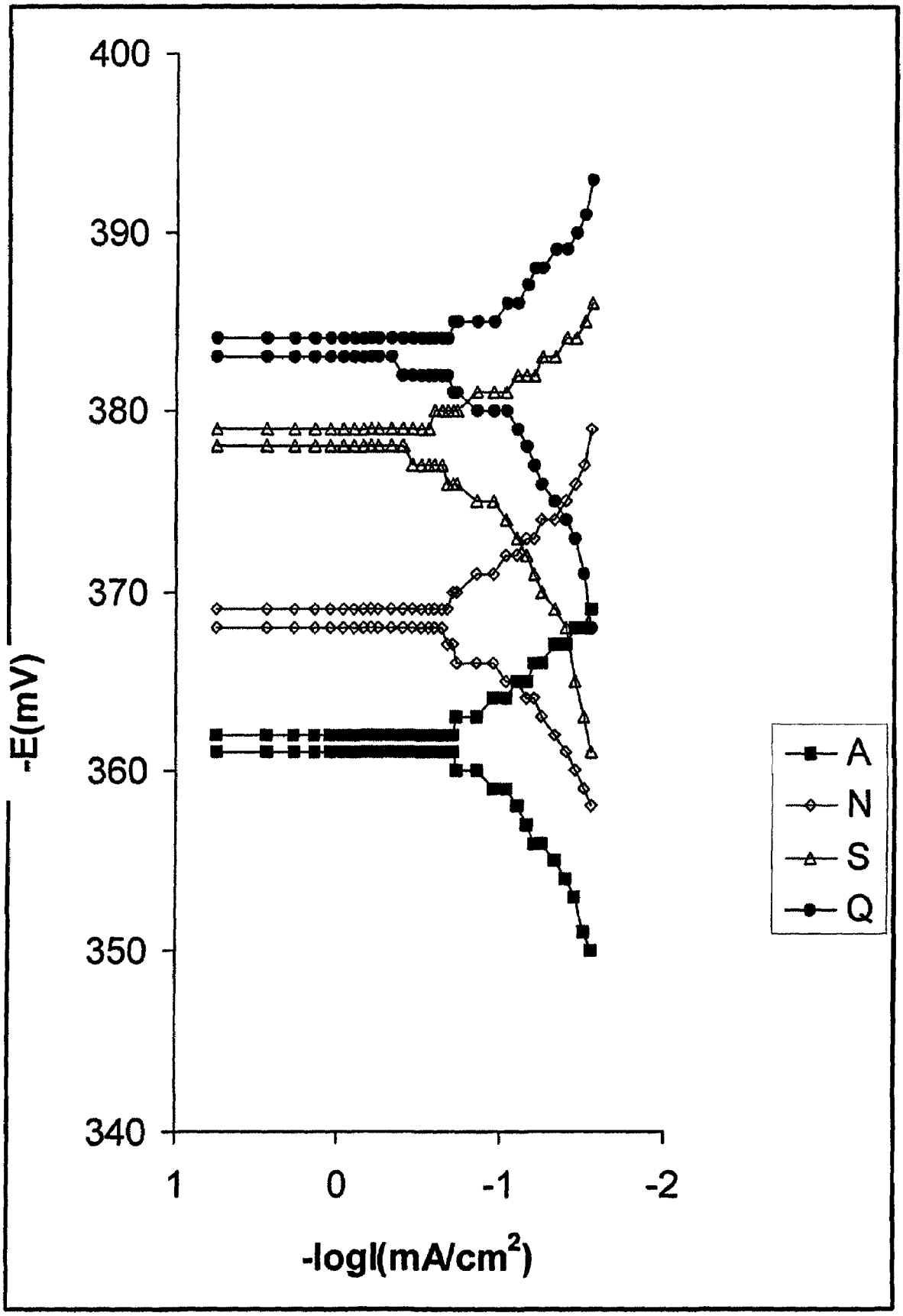
The cathodic and anodic current, i_c & i_a, were used to calculate the cathodic and anodic polarization current density i_c or i_a, by surface area of the working electrode, for every metal sample. Also, the corresponding over potential (E), values were recorded. The above data were plotted diagrammatically where (-E) values were plotted against (-log I) values according to Tafel's equation, for all systems under study.

Figures (16-47) represent Tafel's lines for low carbon vanadium steel samples in (0.1,0.3, and 0.5 M) of HNO_3 and in 0.1 M HNO_3 in various concentration of HEAA ($2x10^{-5}$,$4x10^{-5}$, $6\ x10^{-5}$,$8\ x10^{-5}$ and 10^{-4}M) at 25, 35, 45 and 55°C respectively.

Figures (48-79) represent Tafel's lines for medium carbon vanadium steel samples in (0.1, 0.3, and 0.5 M) of HNO_3 and in 0.1 M HNO_3 in various concentration of HEAA ($2x10^{-5}$, $4x10^{-5}$, $6\ x10^{-5}$, $8\ x10^{-5}$ and 10^{-4}M) at 25, 35, 45 and 55°C respectively.



Fig(16):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 at 25 °C



Fig(17):Tafle lines for L.C.V. steel samples in 0.3 M HNO_3 at 25 °C

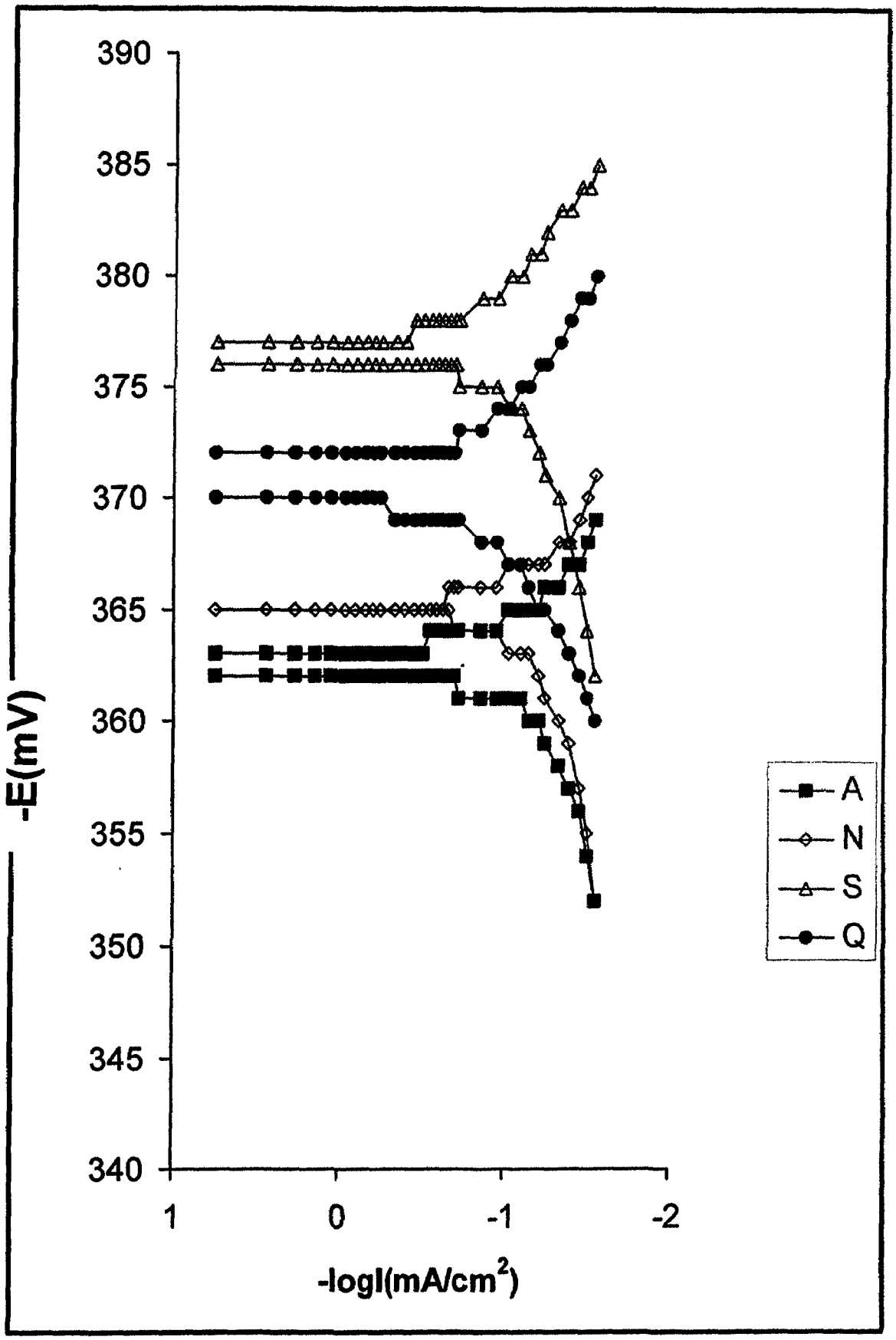


Fig (18): Tafle lines for L.C.V. steel samples in 0.5M HNO_3 at 25°C

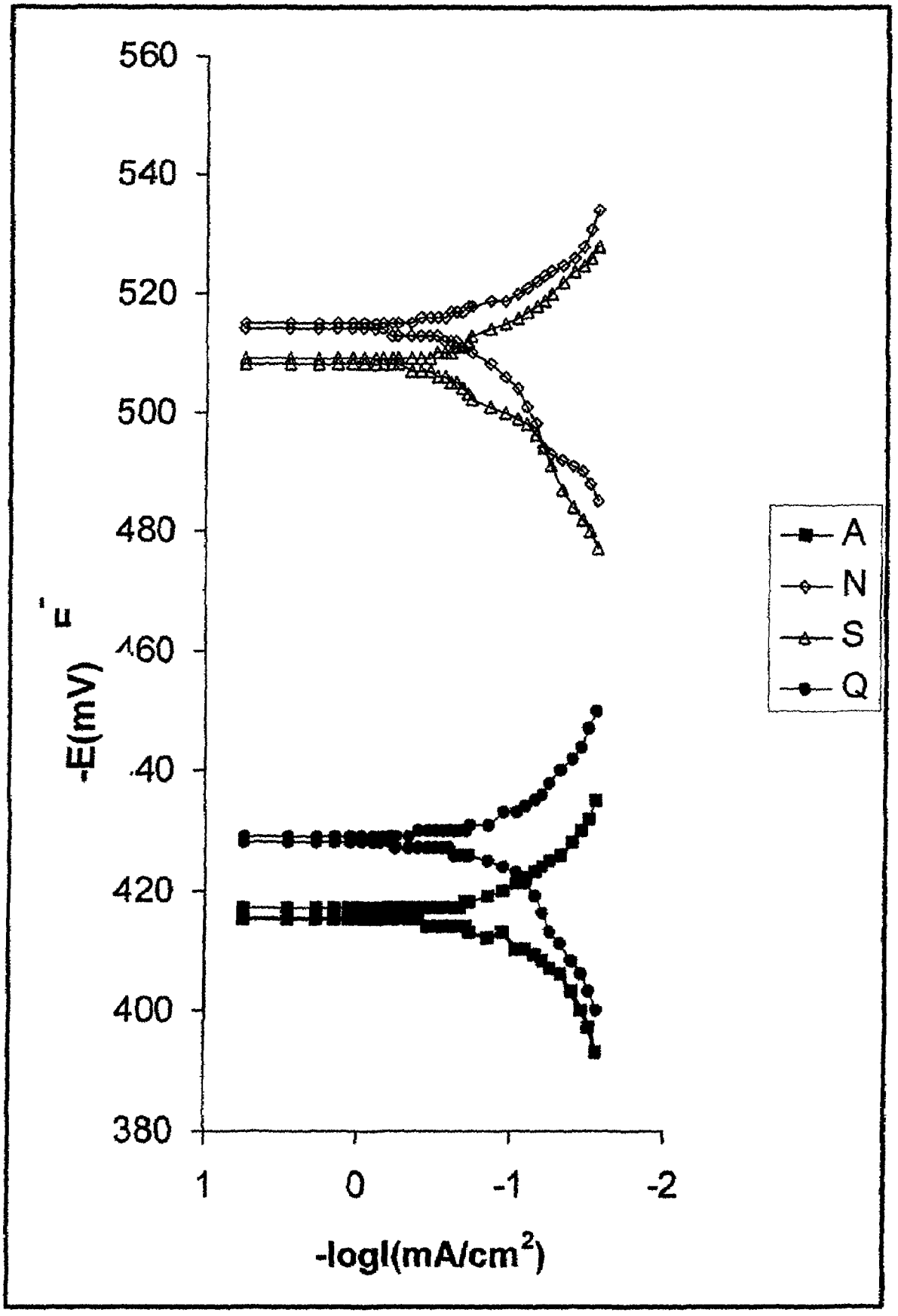
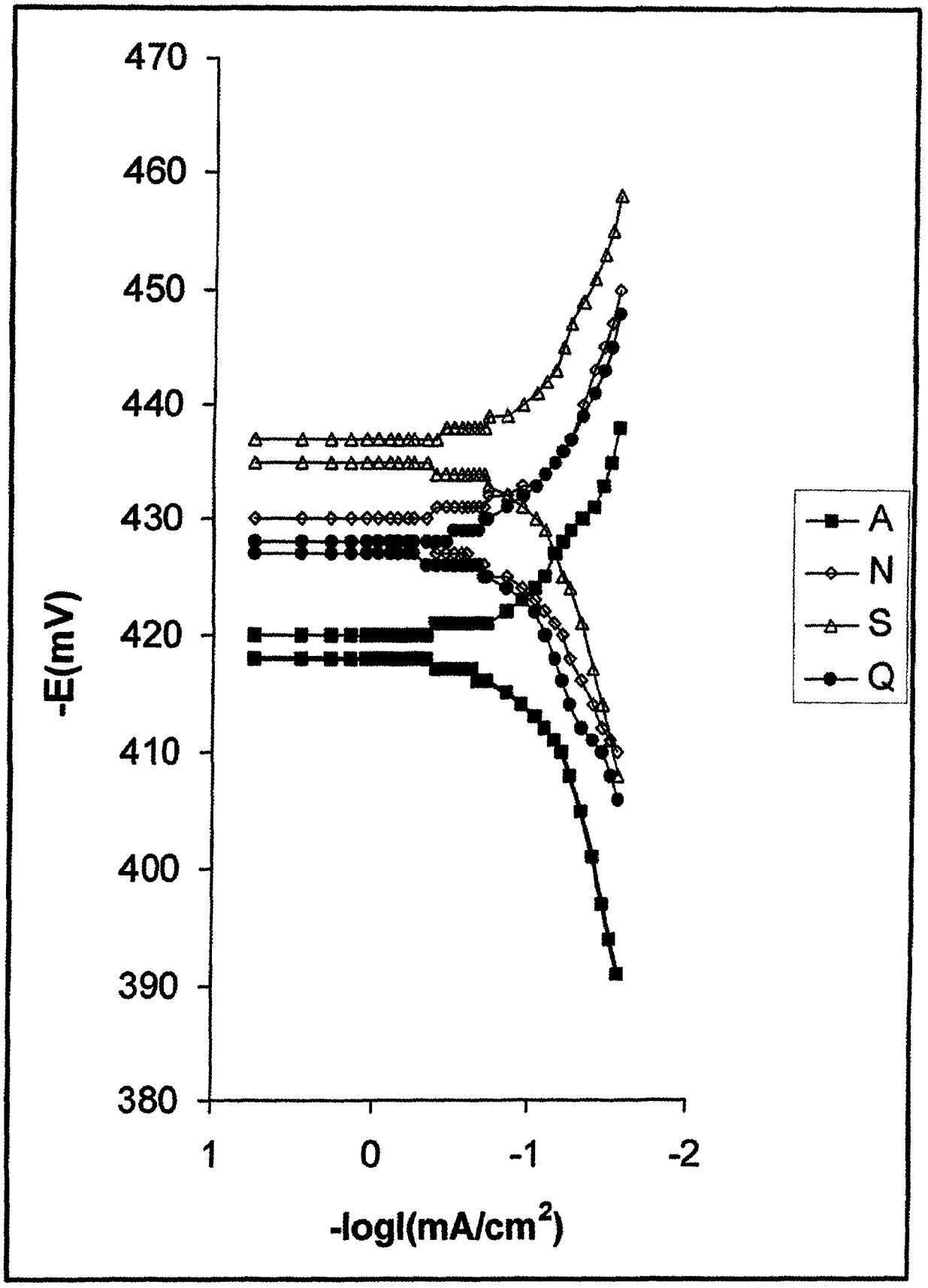
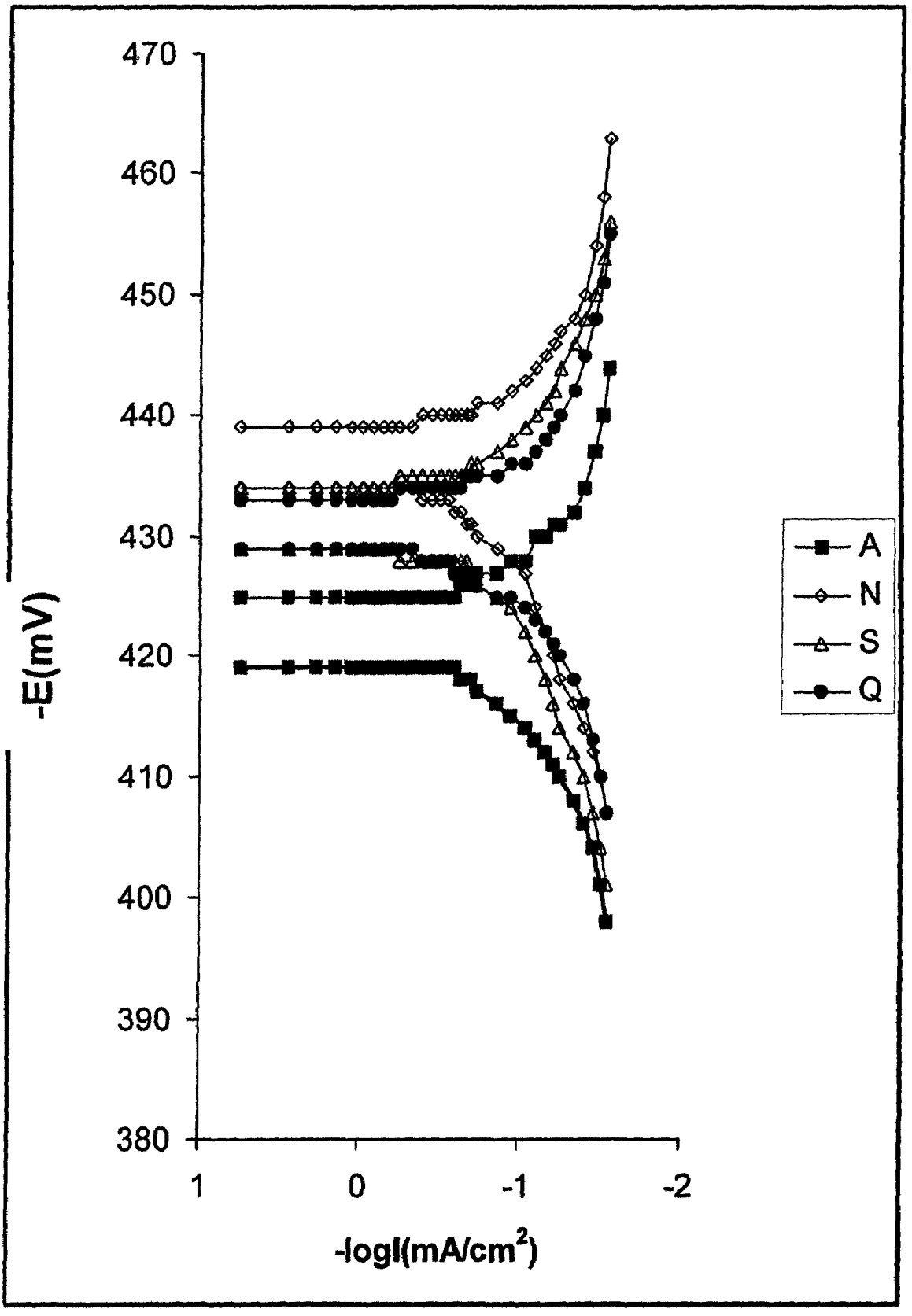


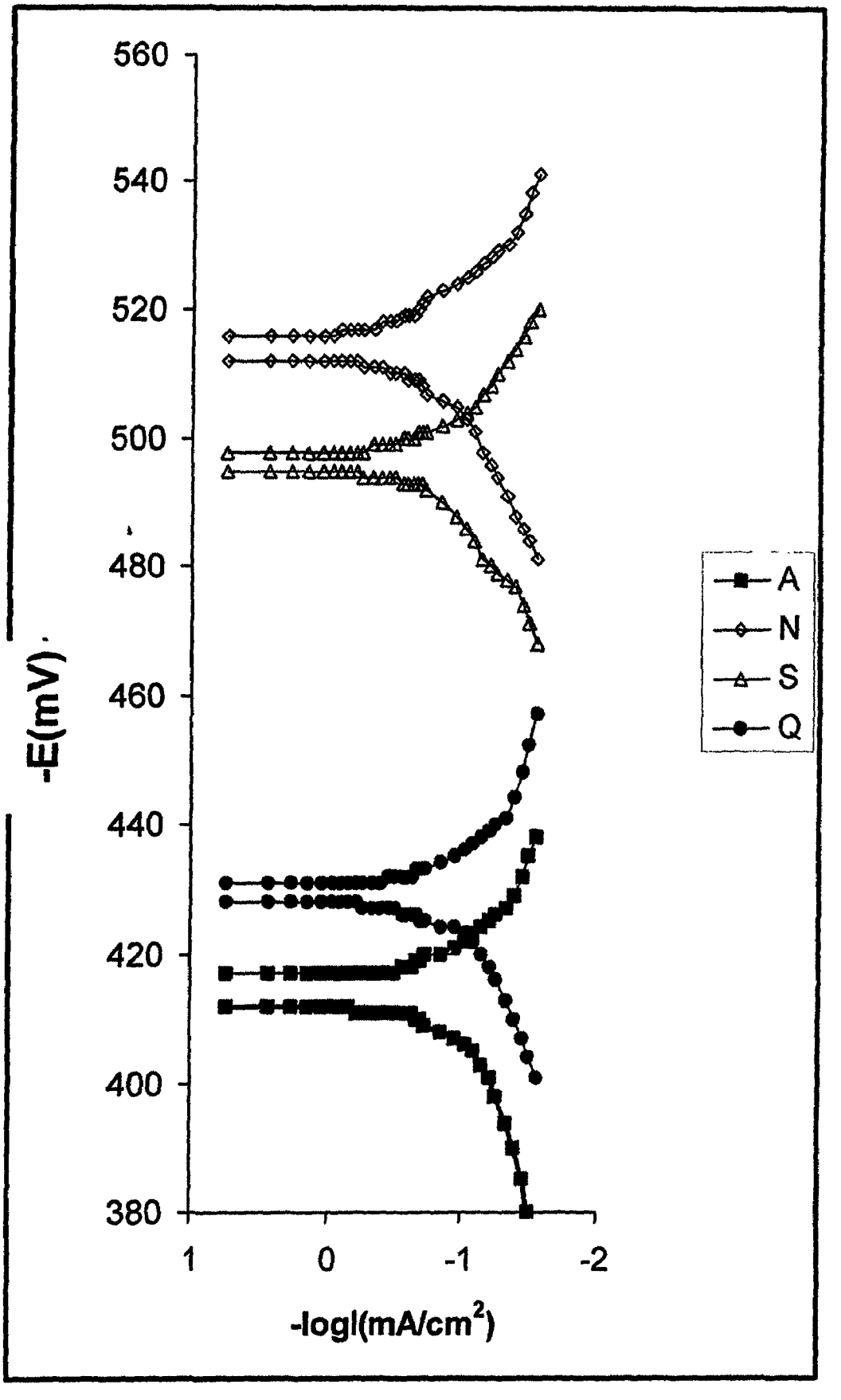
Fig (19): Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 2 x10^{-5}M of HEAA at 25°C



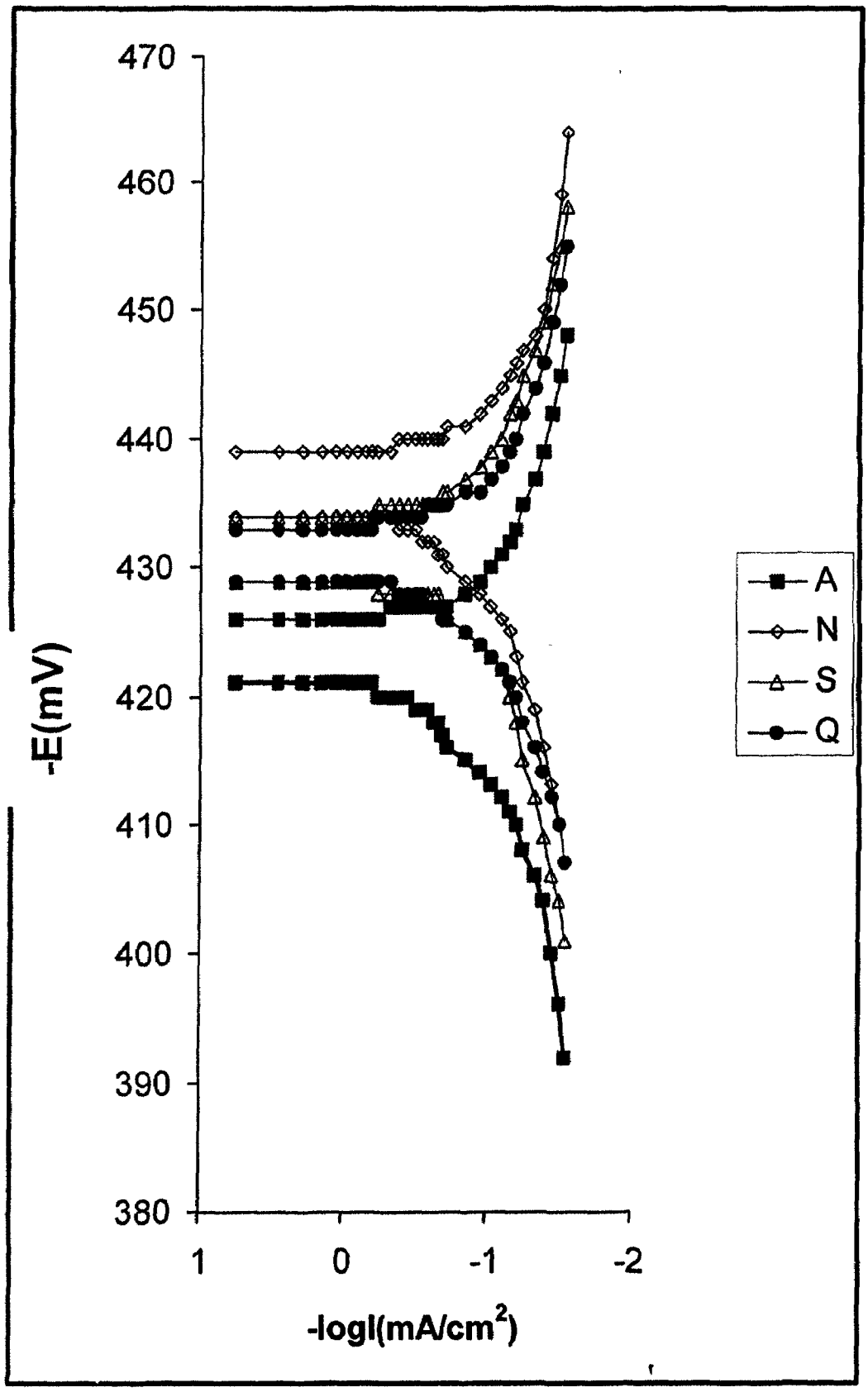
Fig(20):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 4 x10^{-5}M of HEAA at 25 °C



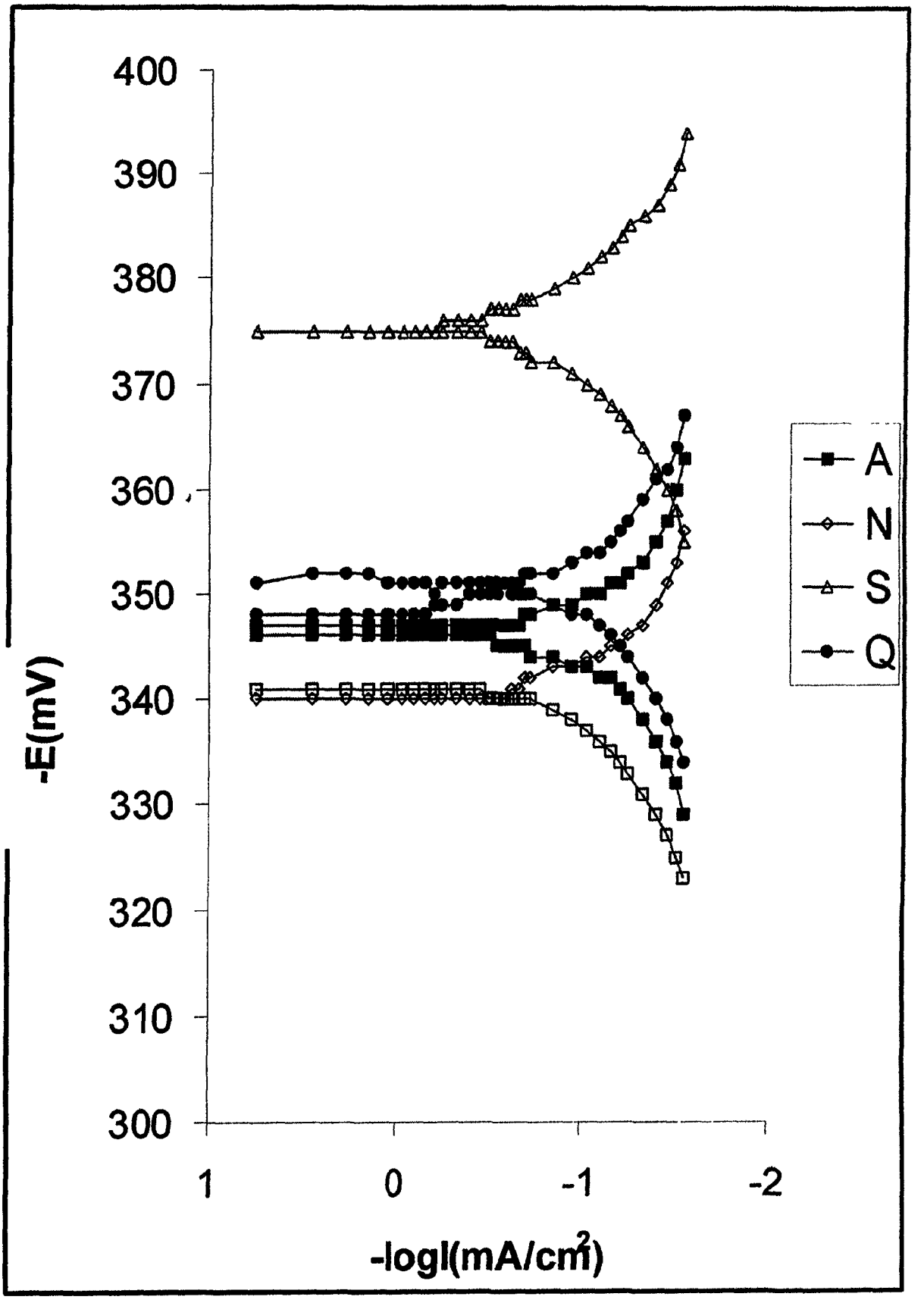
Fig(21):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 6 x10^{-5}M of HEAA at 25 °C



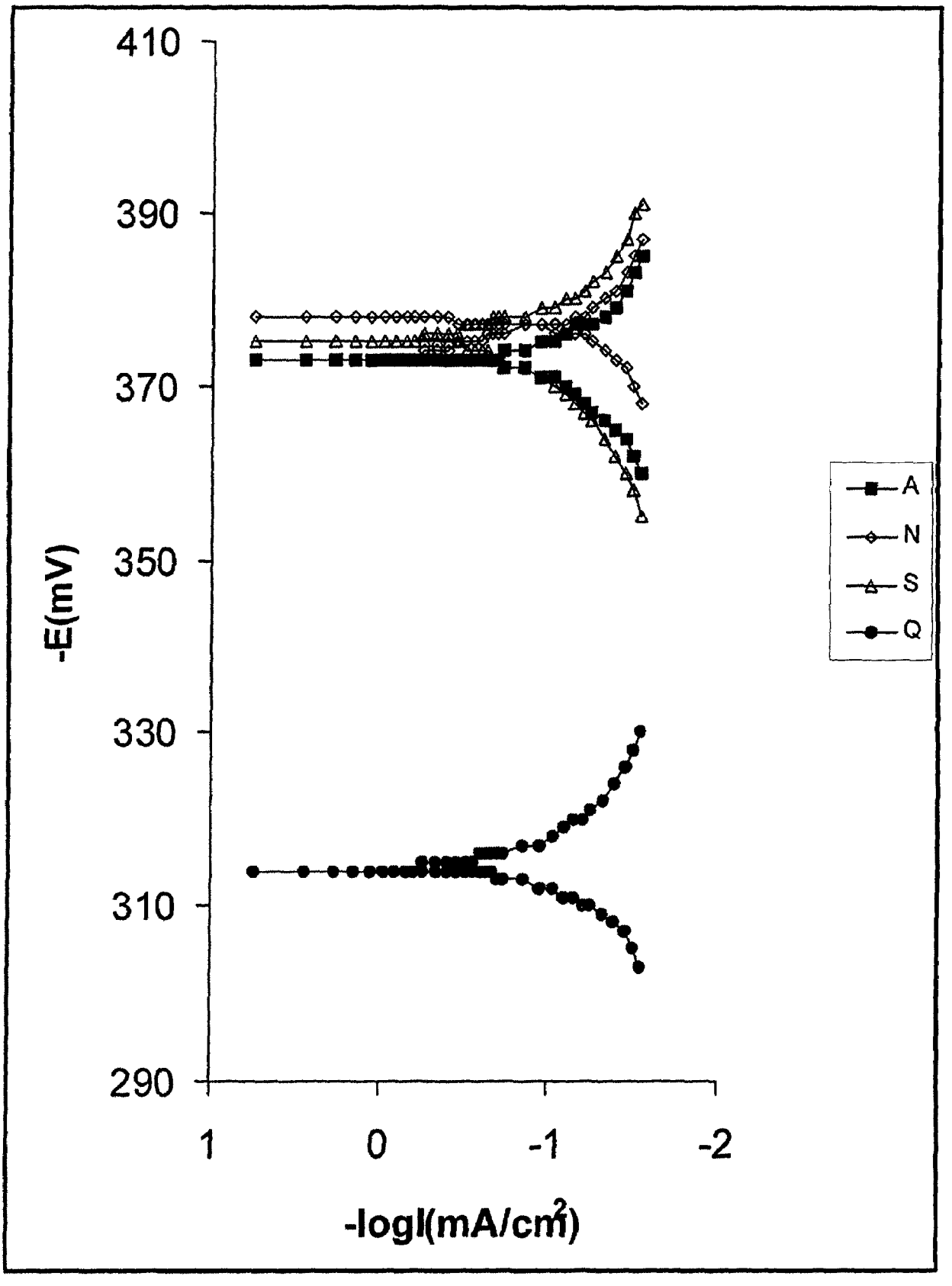
Fig(22):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 8 x10^{-5}M of HEAA at 25 °C



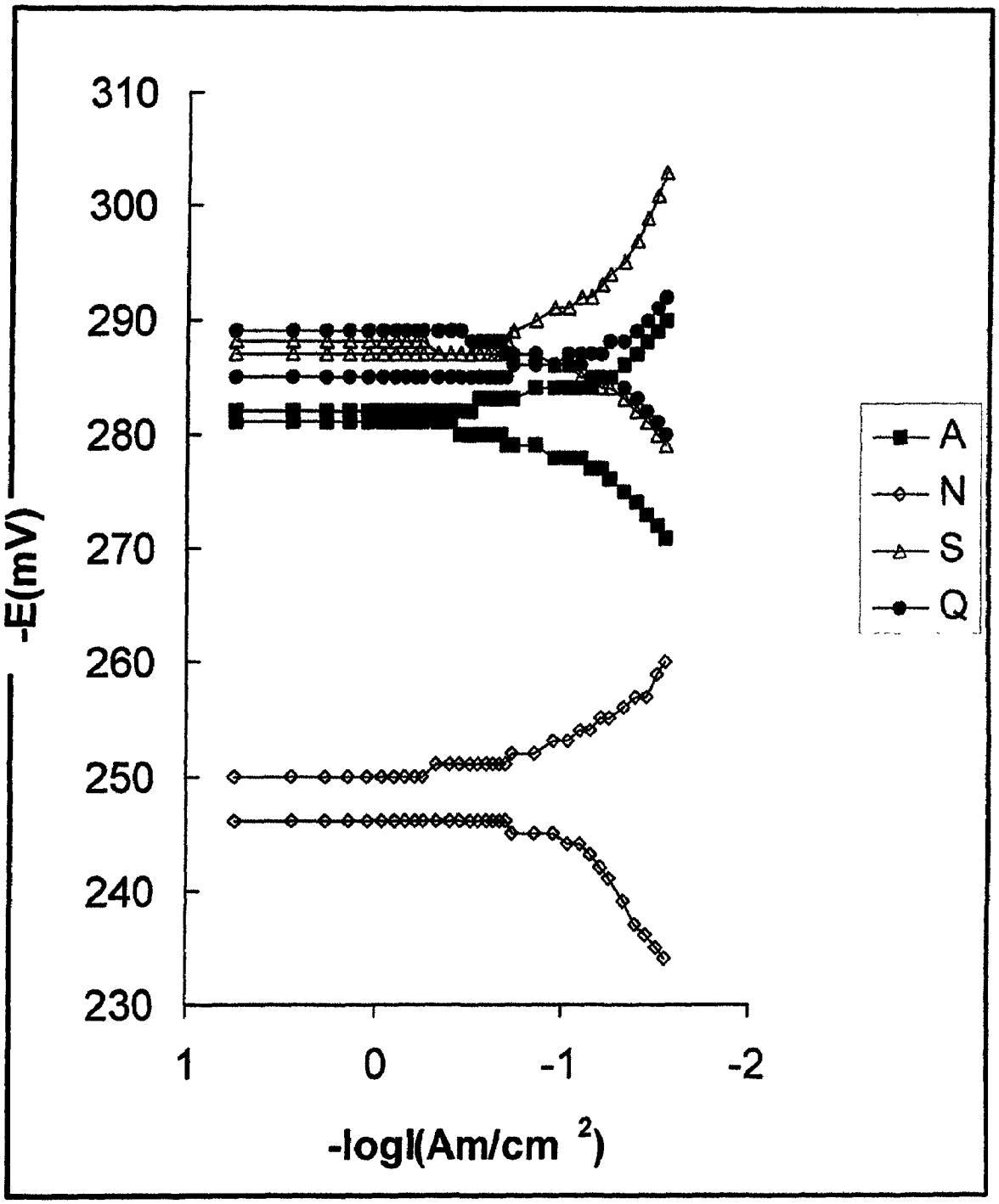
Fig(23):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 10^{-4}M of HEAA at 25 °C



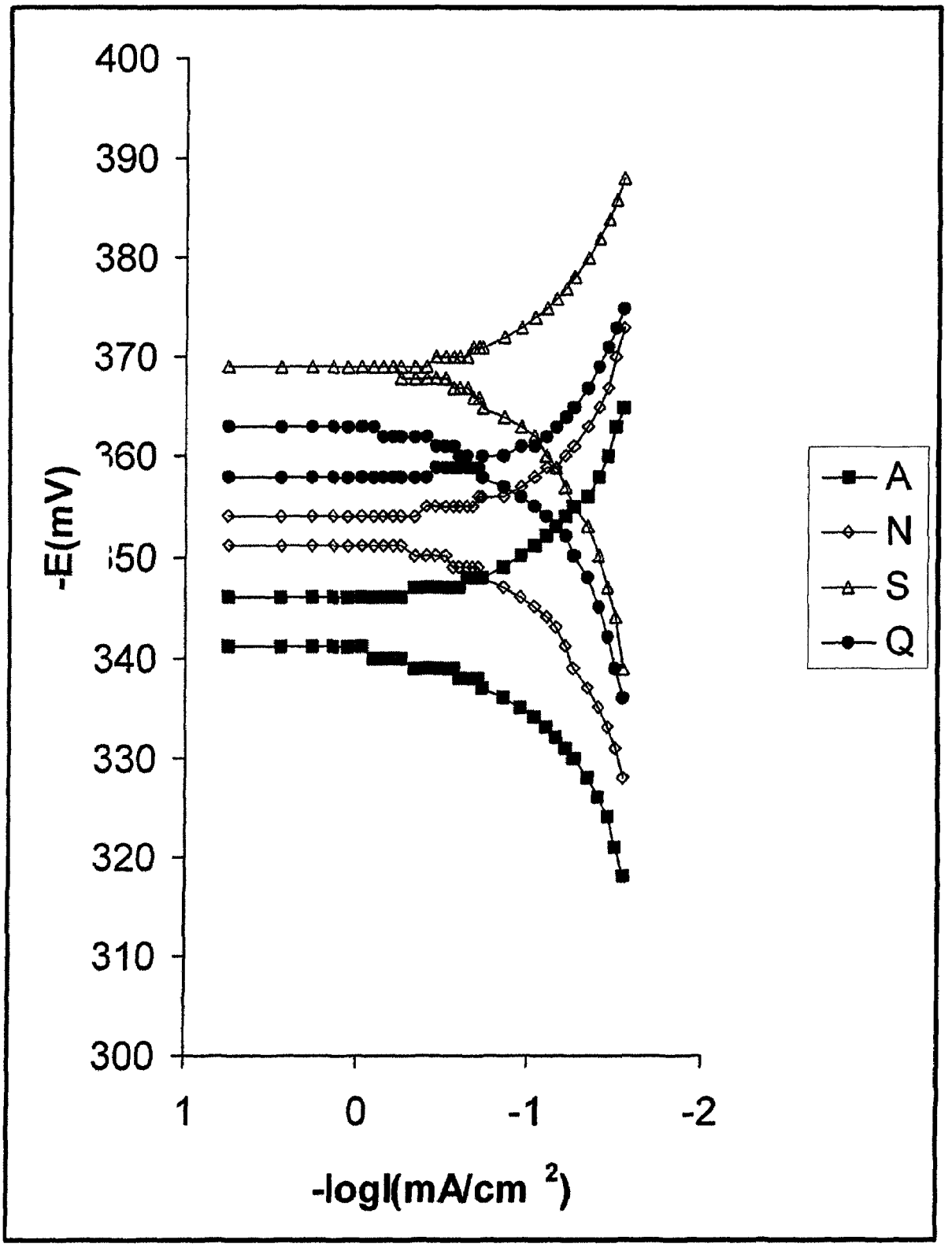
Fig(24):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 at 35 °C



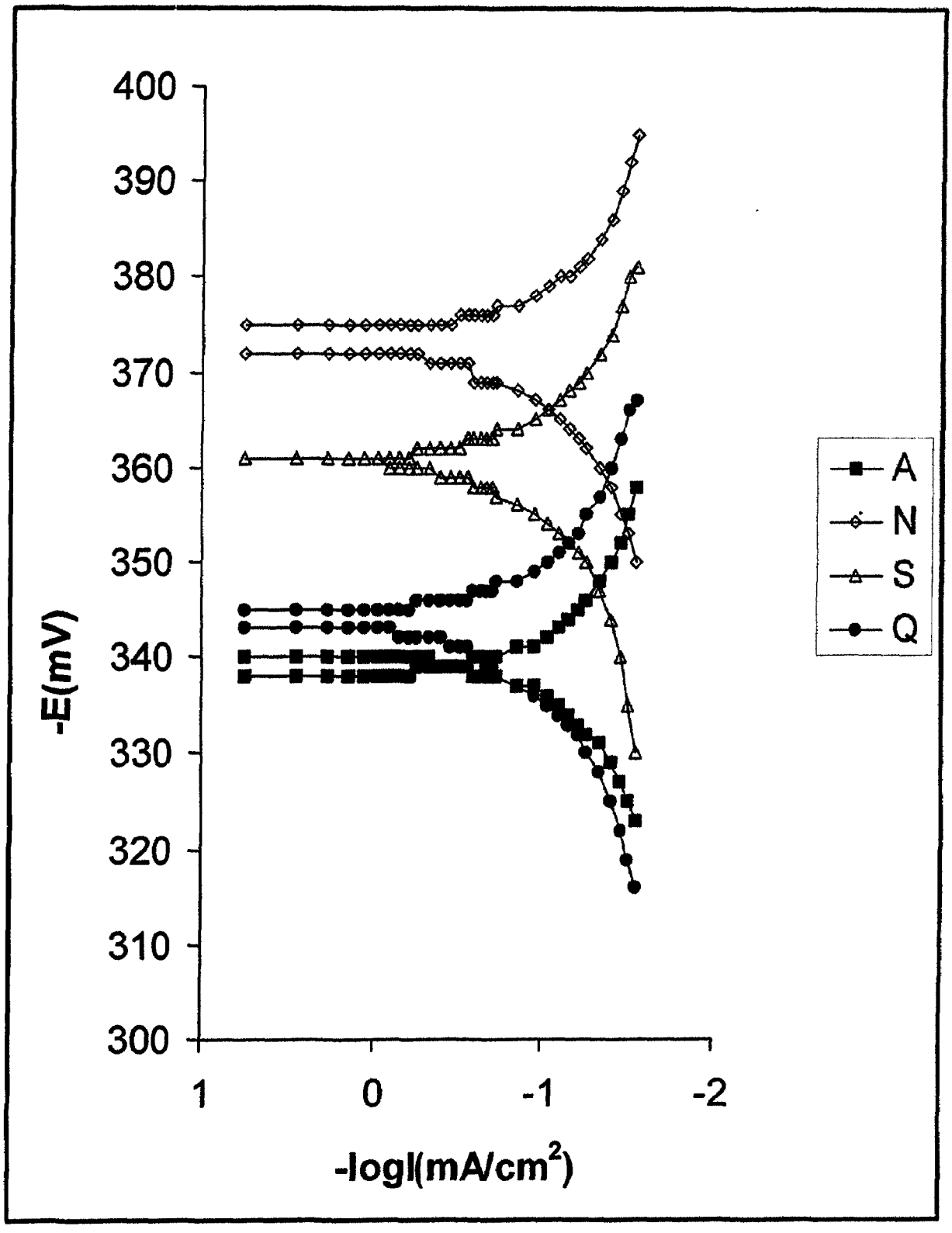
Fig(25):Tafle lines for L.C.V. steel samples in 0.3M HNO_3 at 35 °C



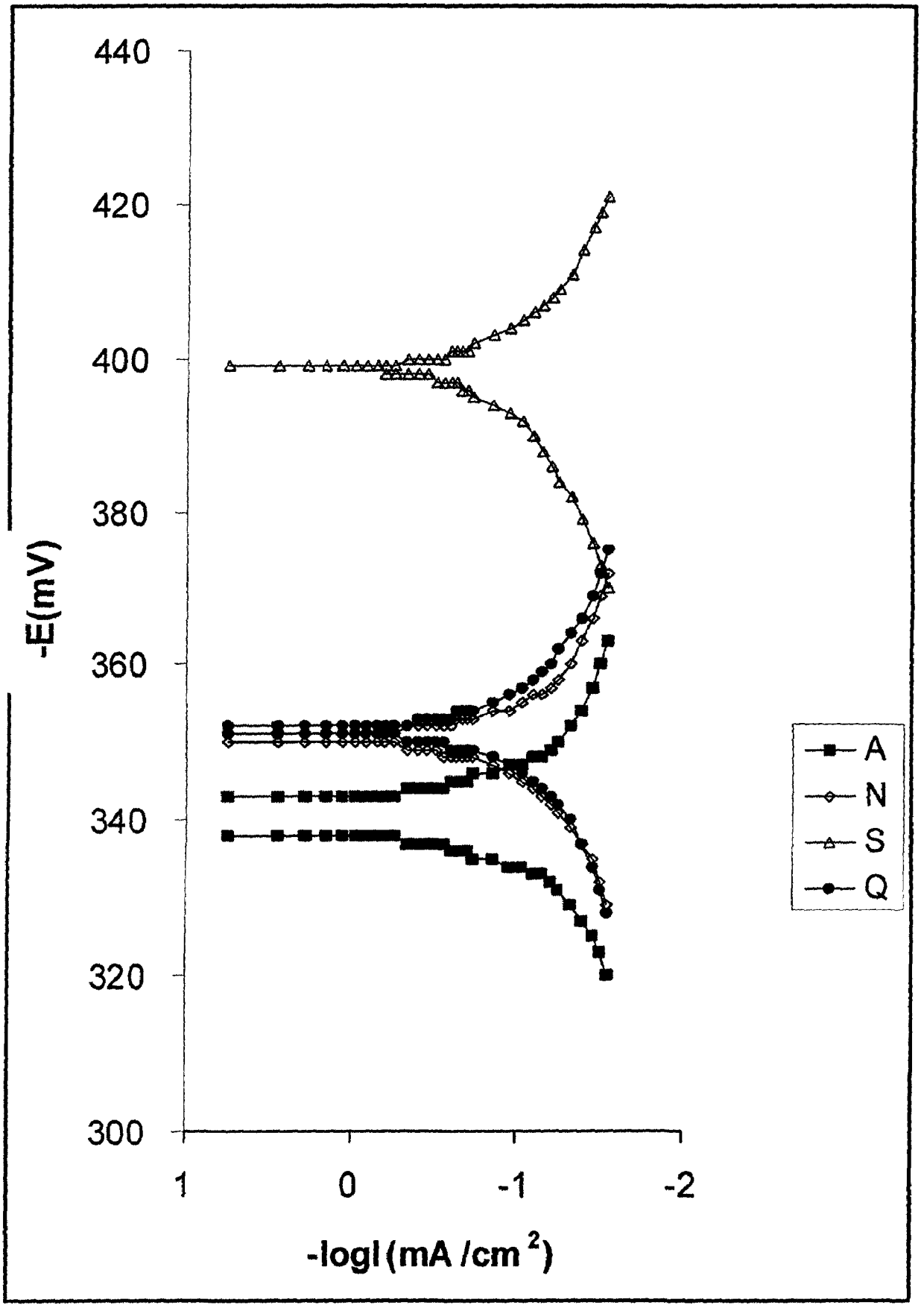
Fig(26):Tafle lines for L.C.V. steel samples in 0.5M HNO_3 at 35 °C



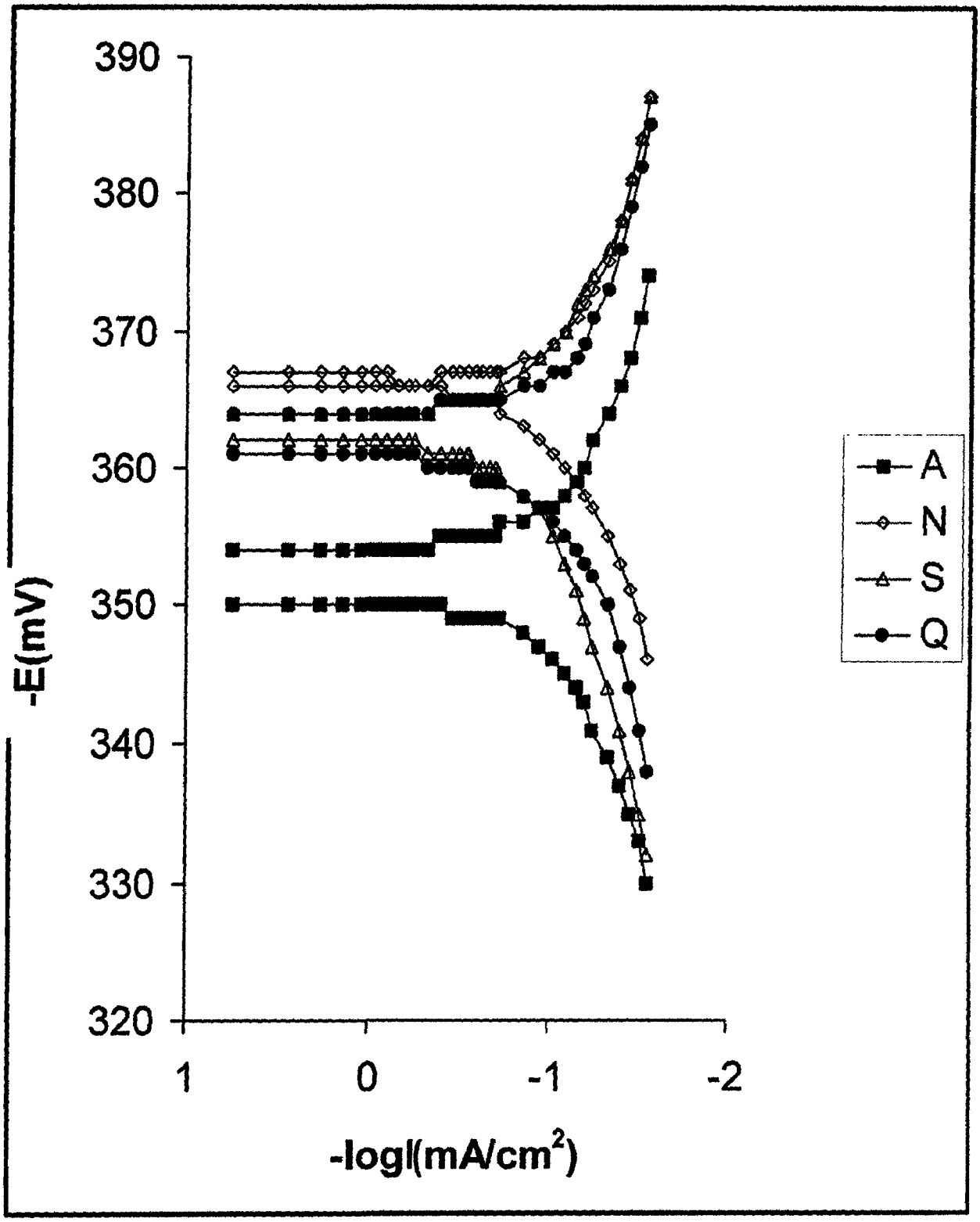
Fig(27):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 2 x10^{-5}M of HEAA at 35 °C



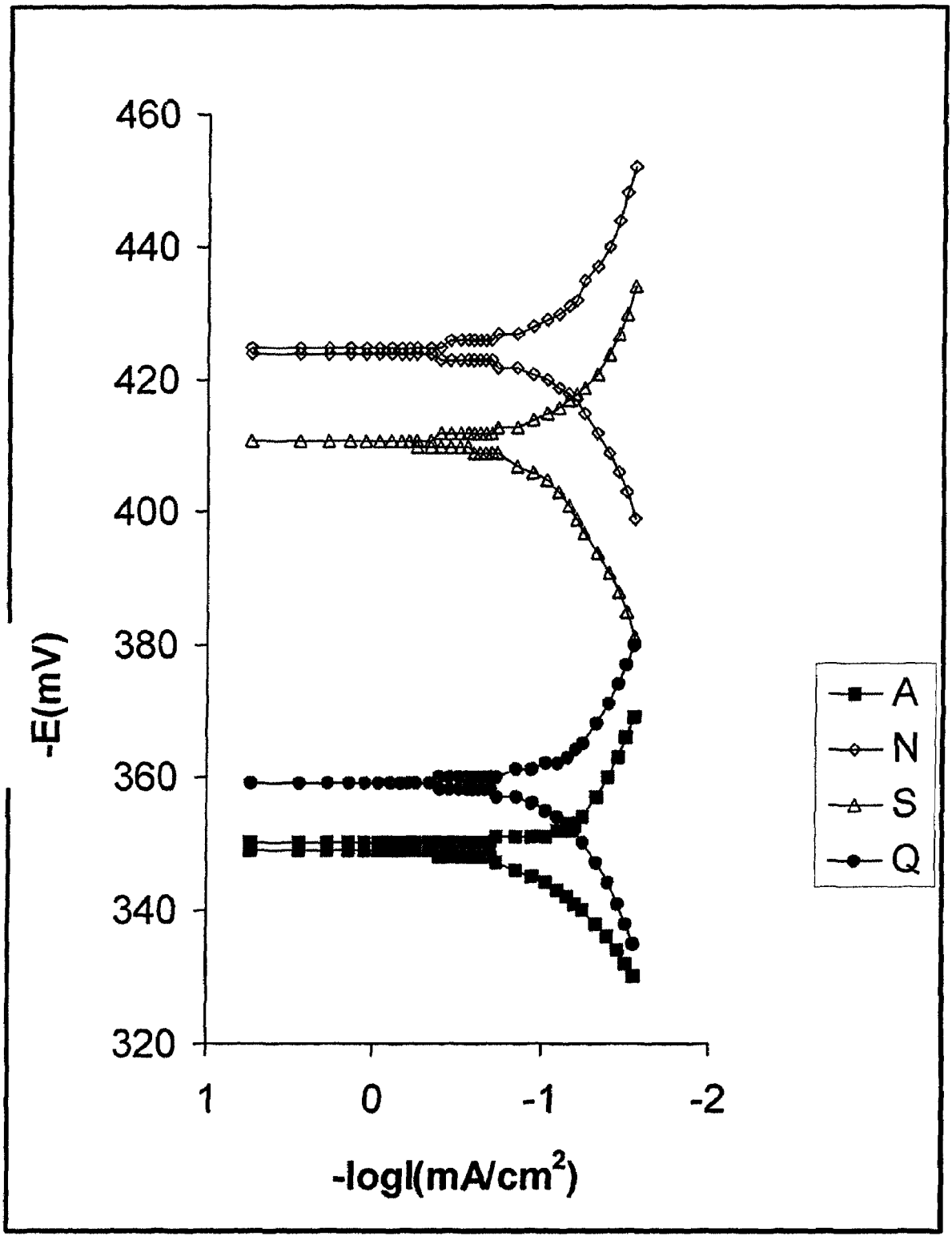
Fig(28):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 4 x10^{-5}M of HEAA at 35 °C



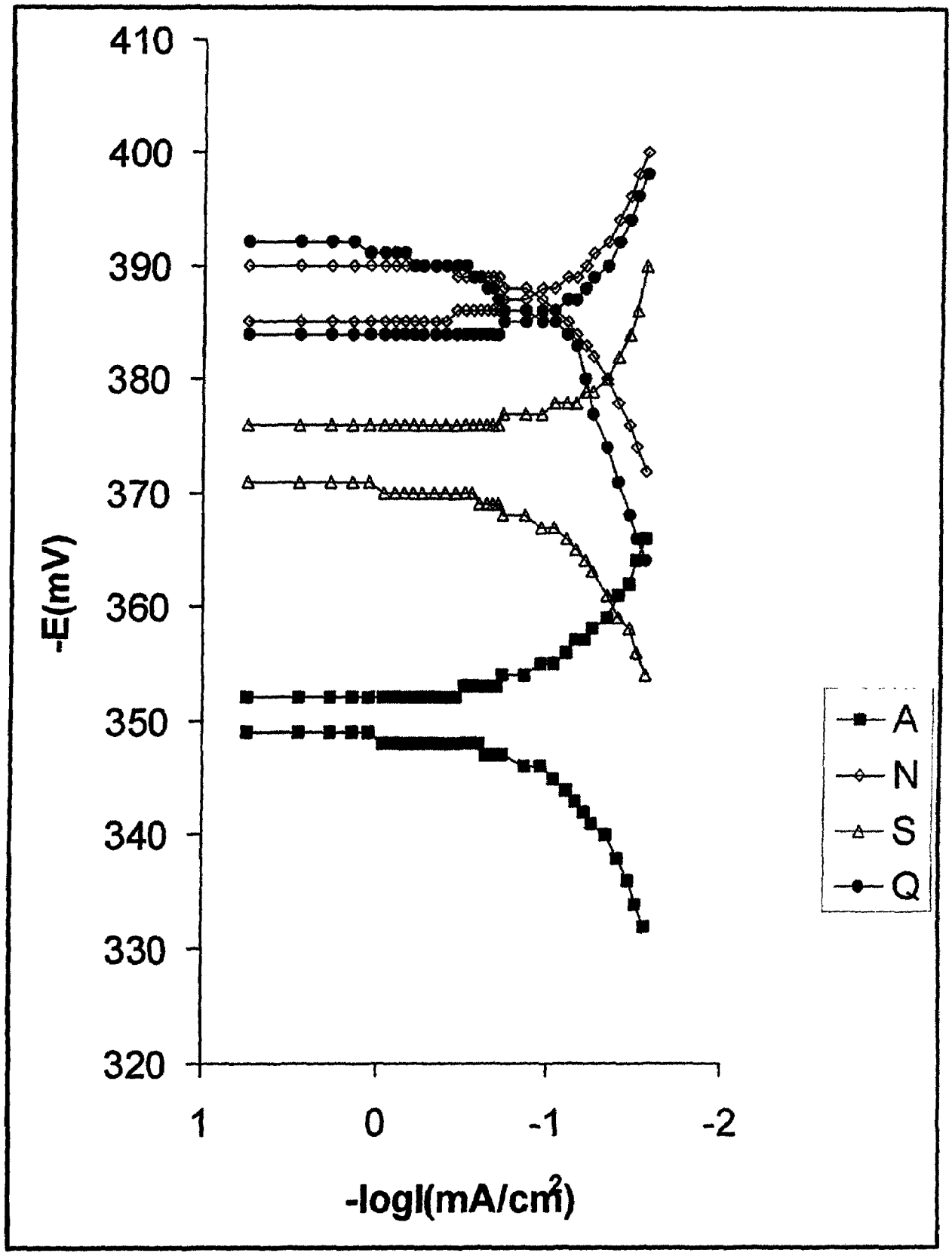
Fig(29):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 6 x10^{-5}M of HEAA at 35 °C



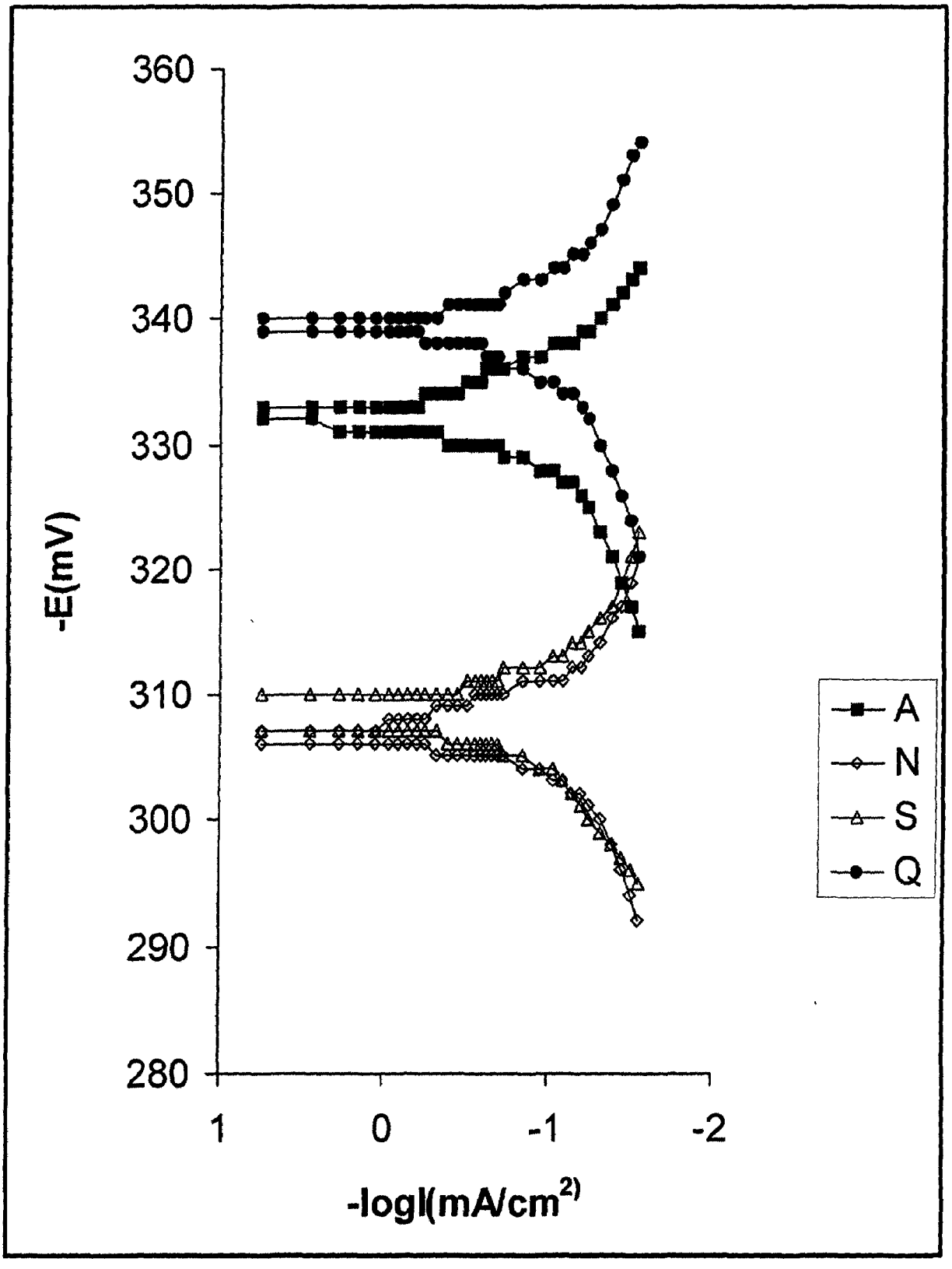
Fig(30):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 8 x10^{-5}M of HEAA at 35 °C



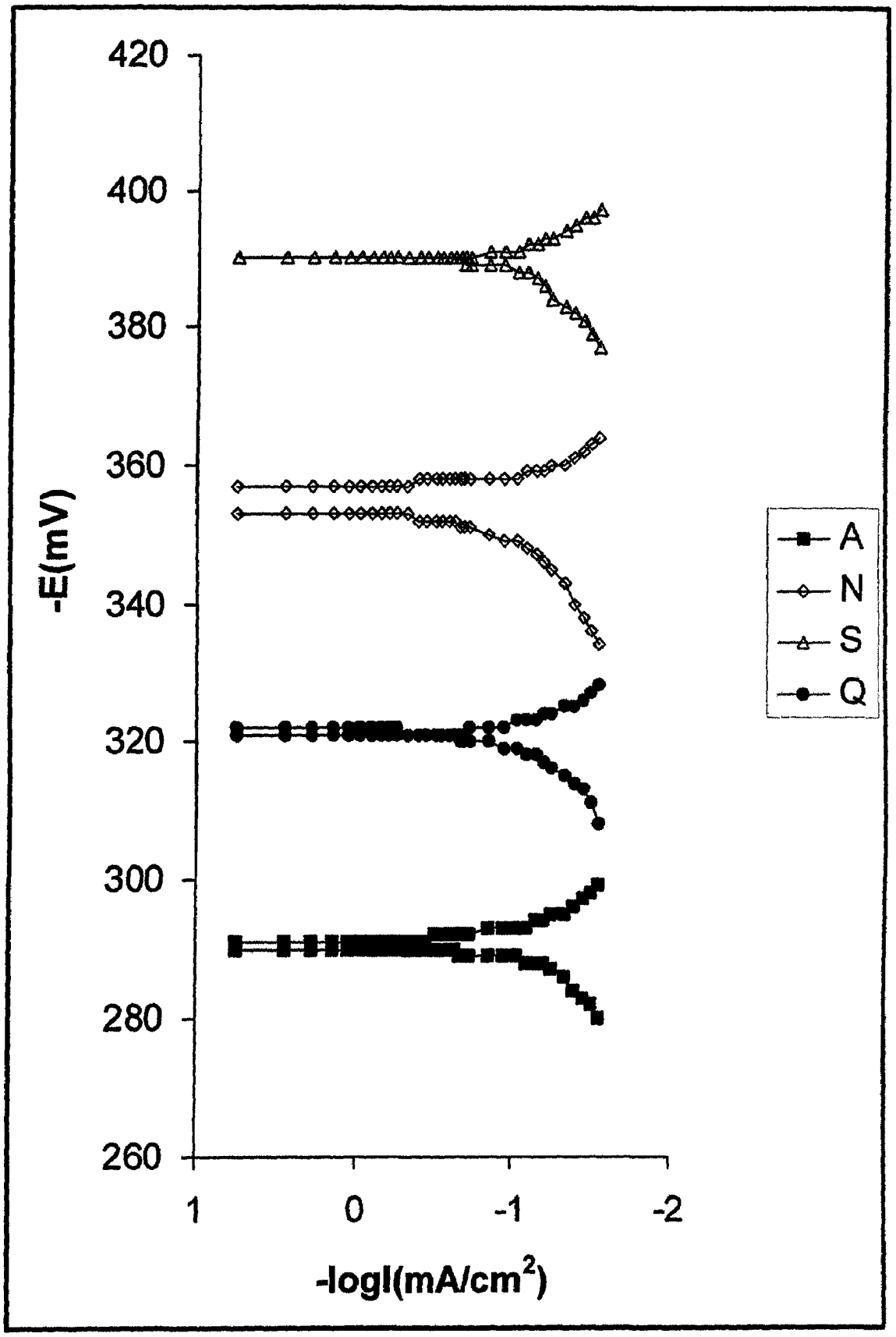
Fig(31):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 10^{-4}M of HEAA at 35 °C



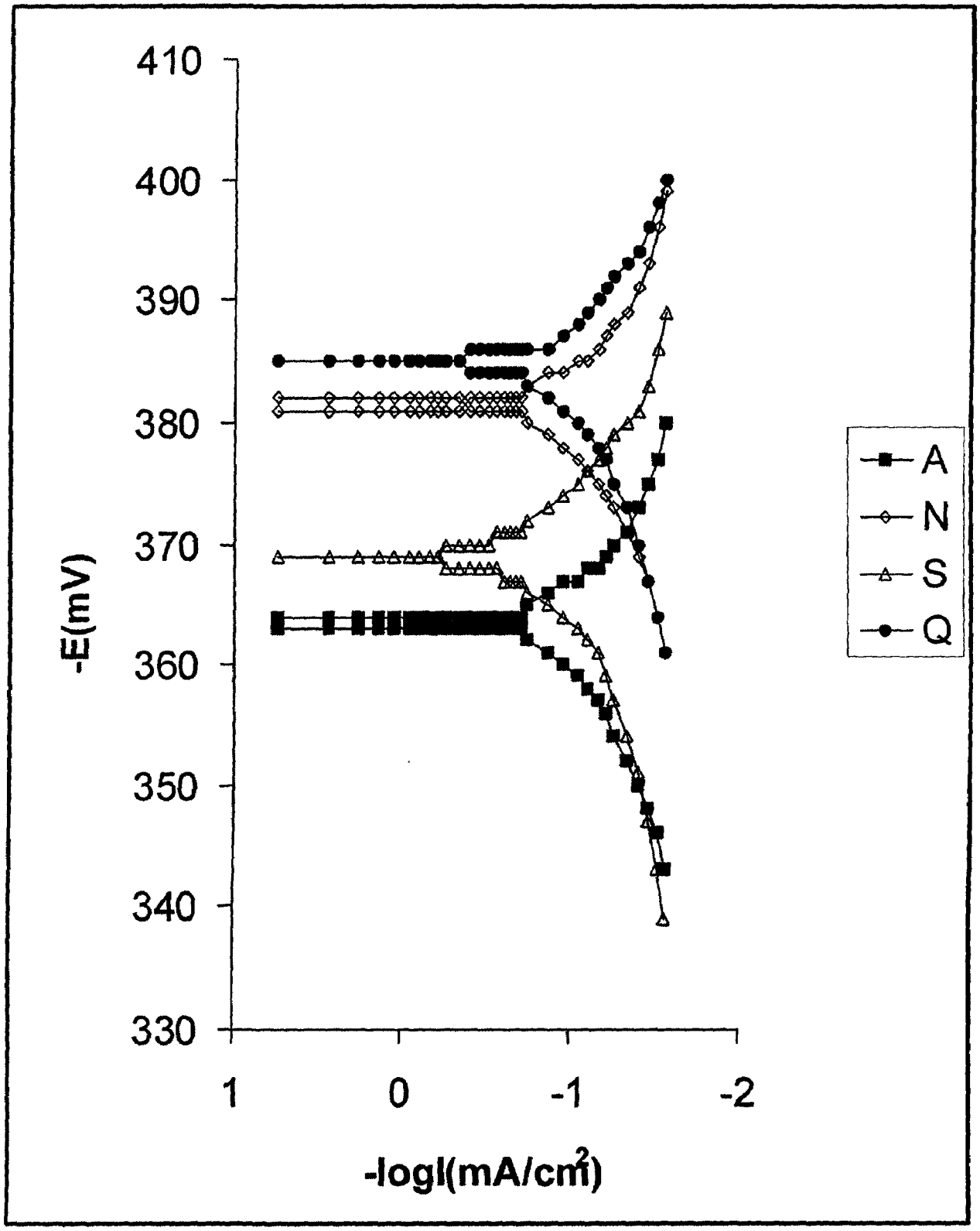
Fig(32):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 at 45 °C



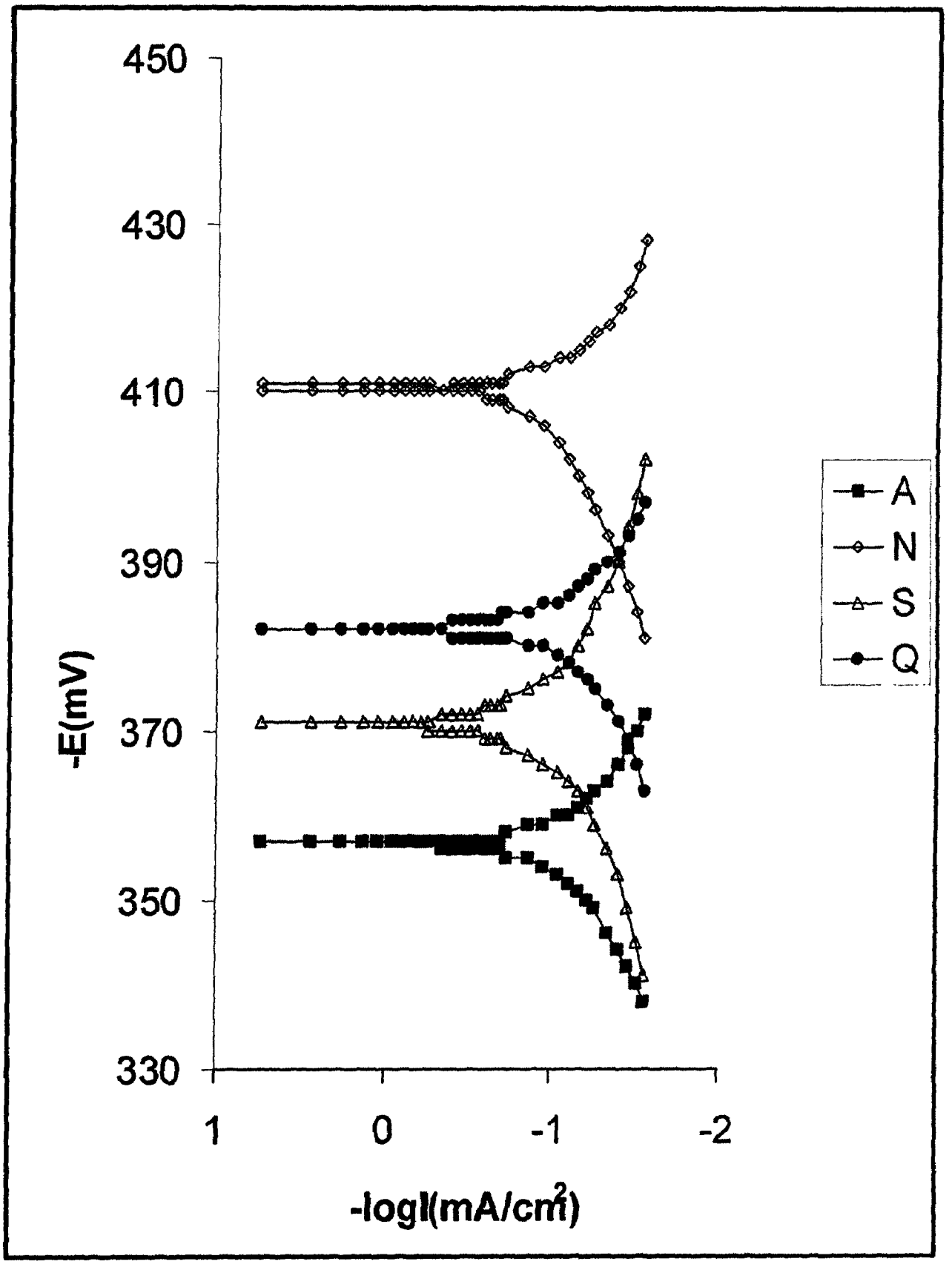
Fig(33):Tafle lines for L.C.V. steel samples in 0.3M HNO_3 at 45°C



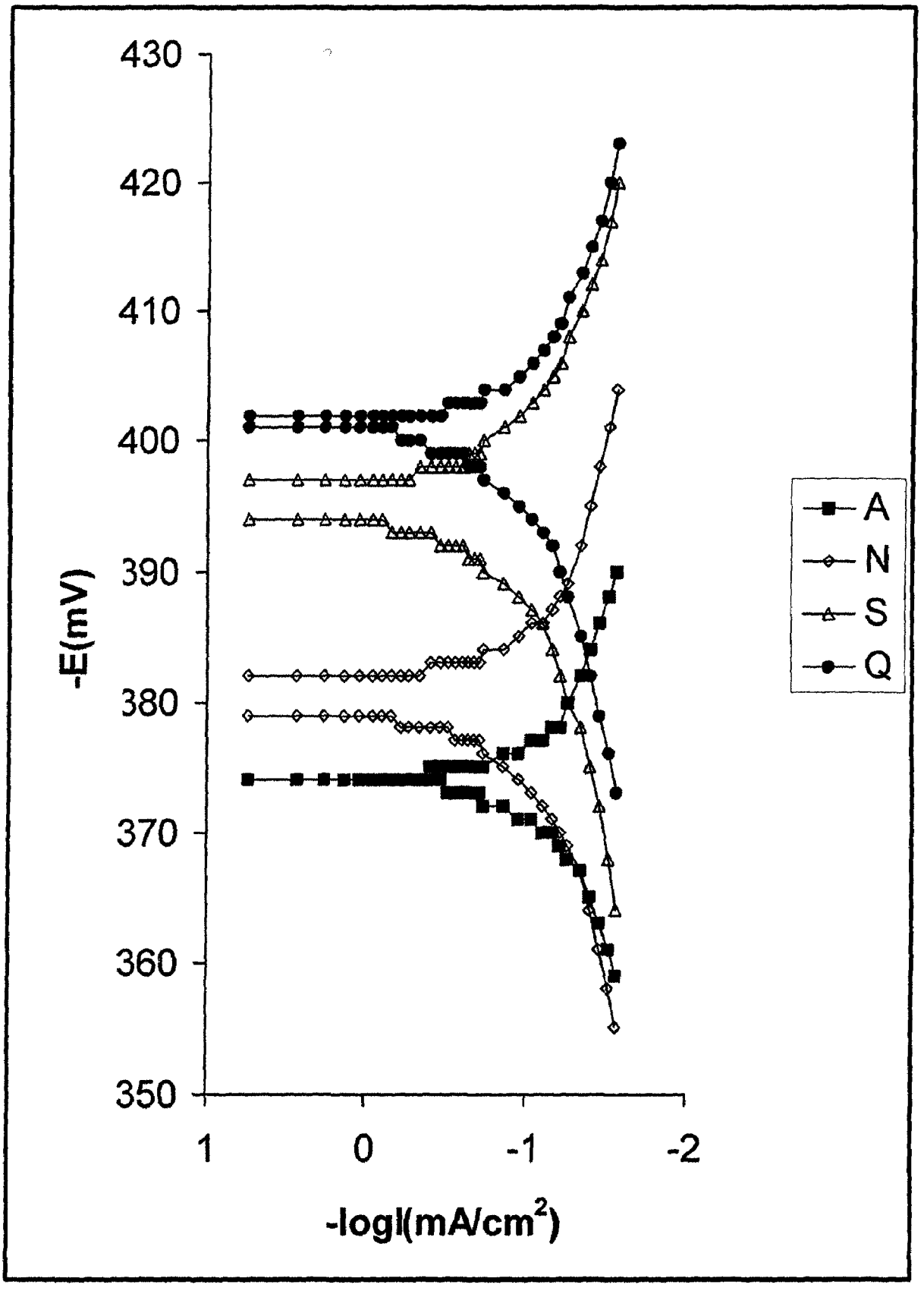
Fig(34):Tafle lines for L.C.V. steel samples in 0.5M HNO_3 at 45°C



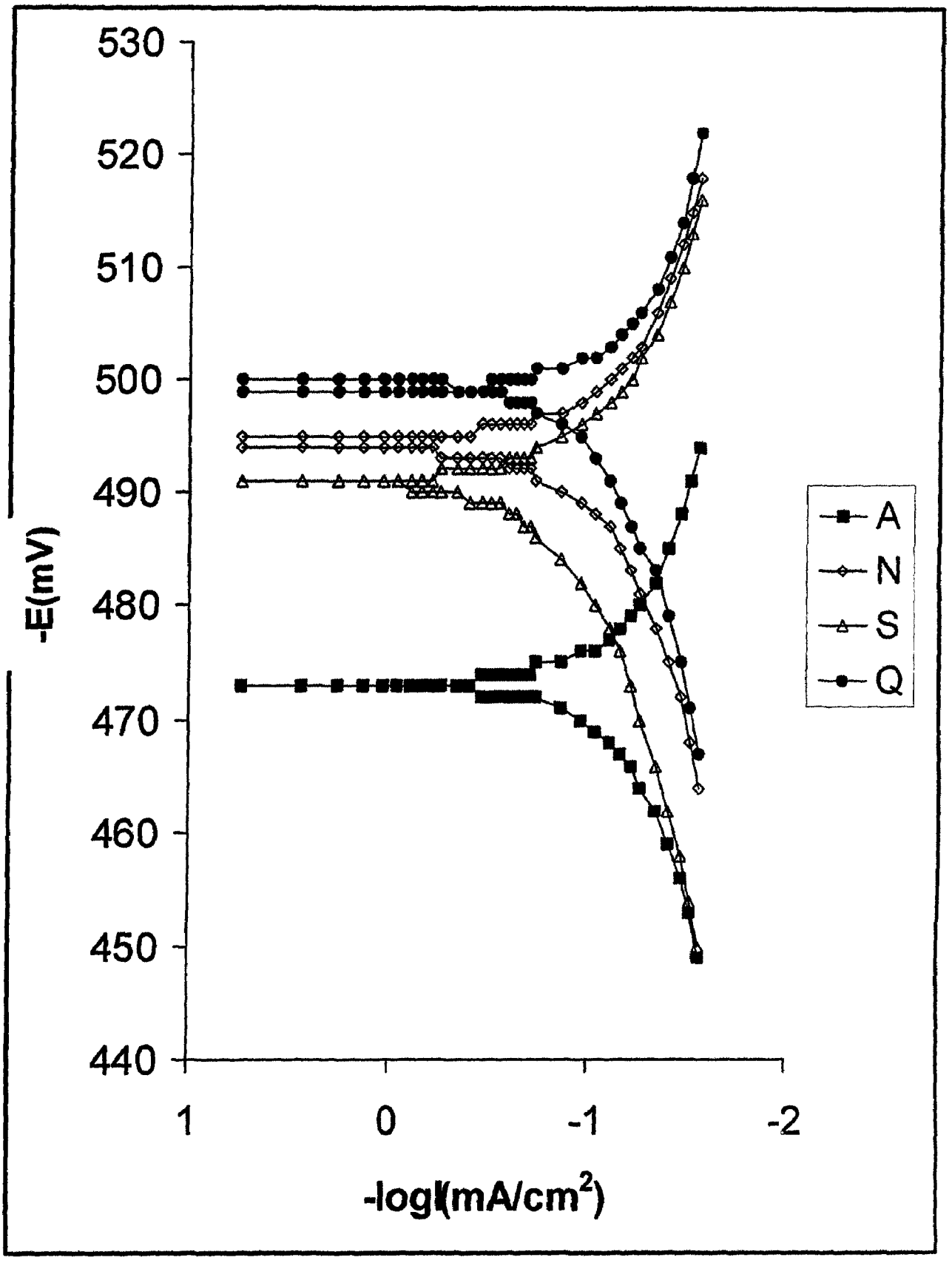
Fig(35):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 2 x10^{-5}M of HEAA at 45 °C



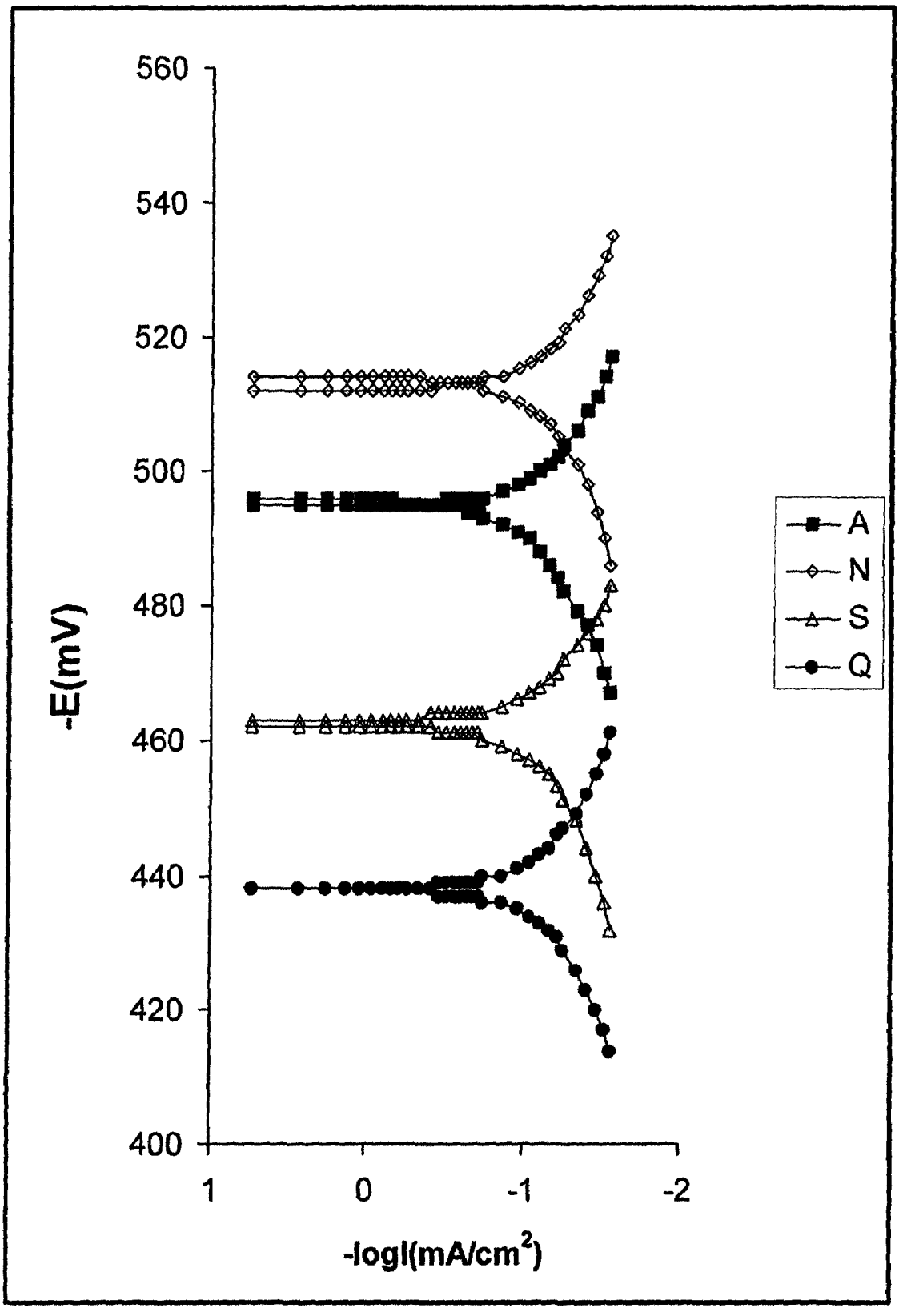
Fig(36):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 4 x10^{-5}M of HEAA at 45 °C



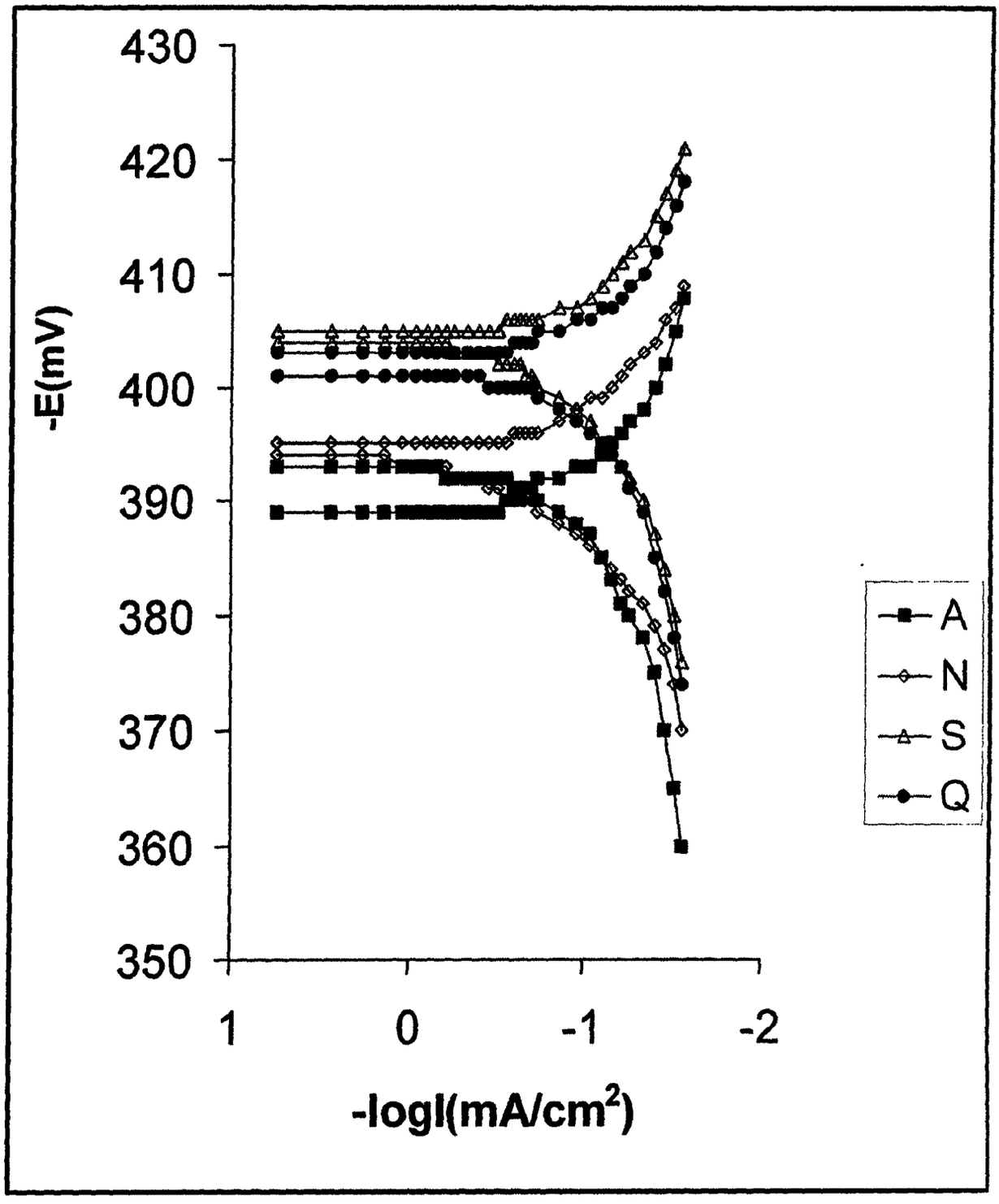
Fig(37):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 6 x10^{-5}M of HEAA at 45 °C



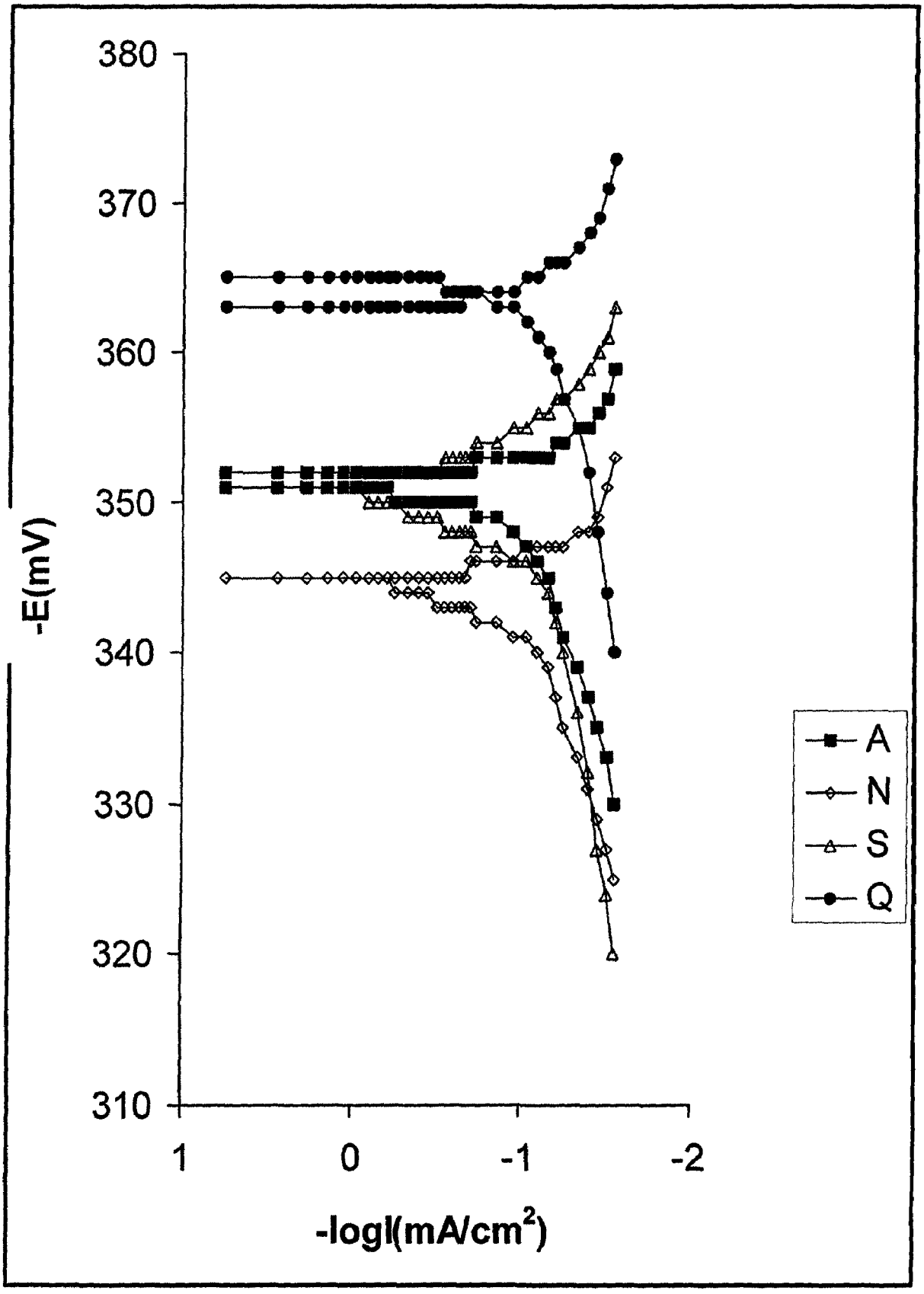
Fig(38):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 8 x10^{-5}M of HEAA at 45 °C



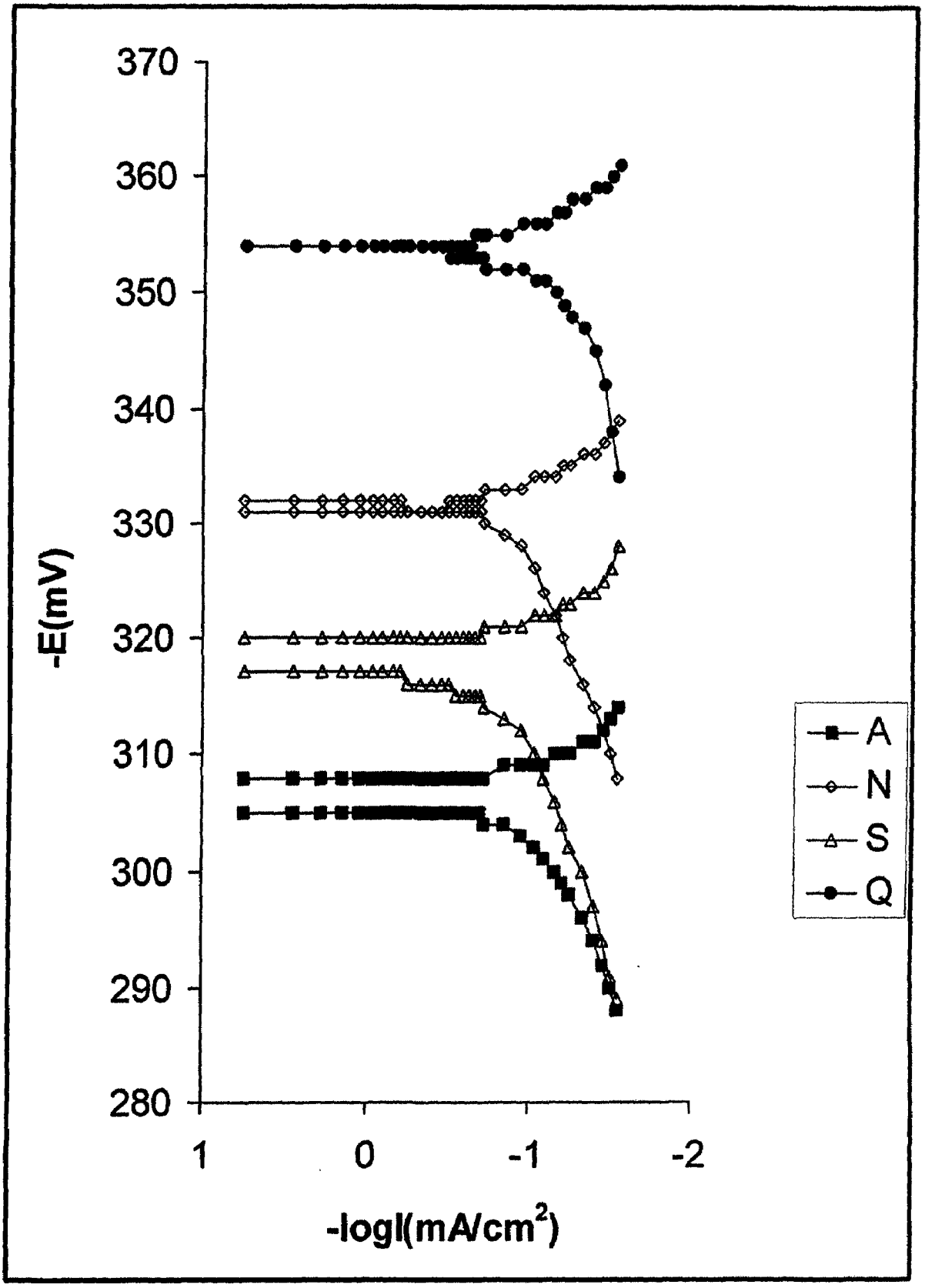
Fig(39):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 10^{-4}M of HEAA at 45 °C



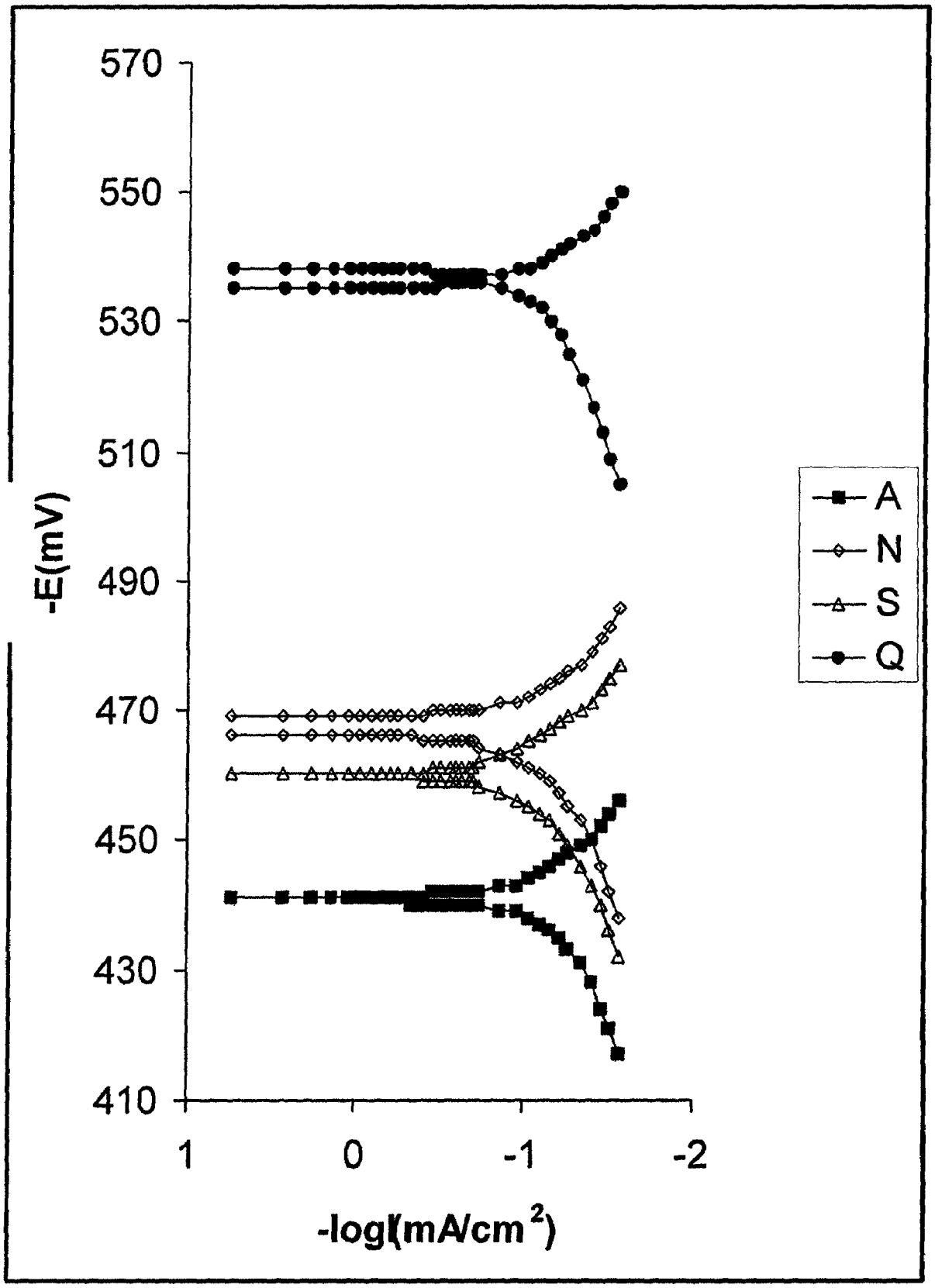
Fig(40):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 at 55 °C



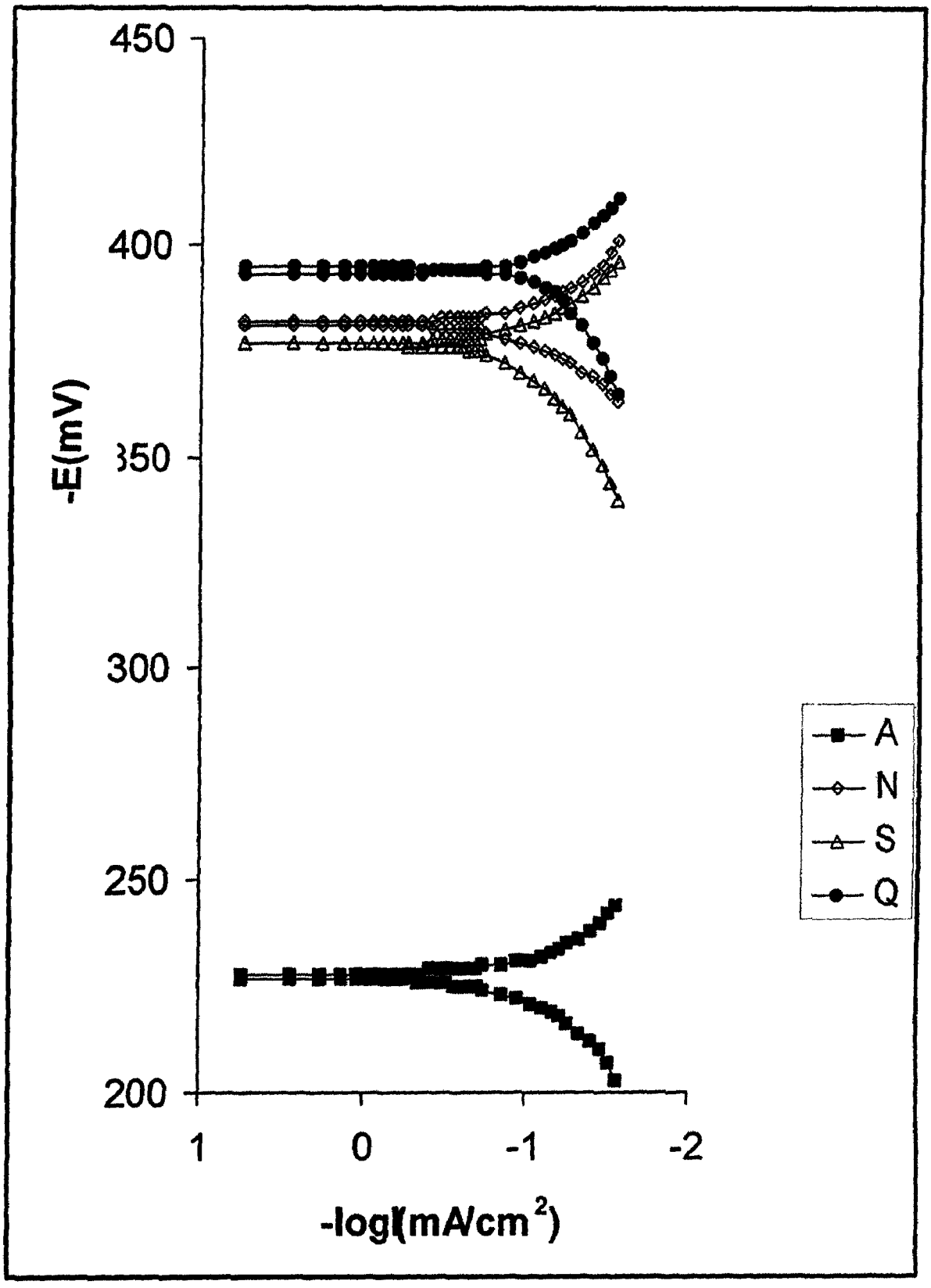
Fig(41):Tafle lines for L.C.V. steel samples in 0.3 M HNO_3 at 55 °C



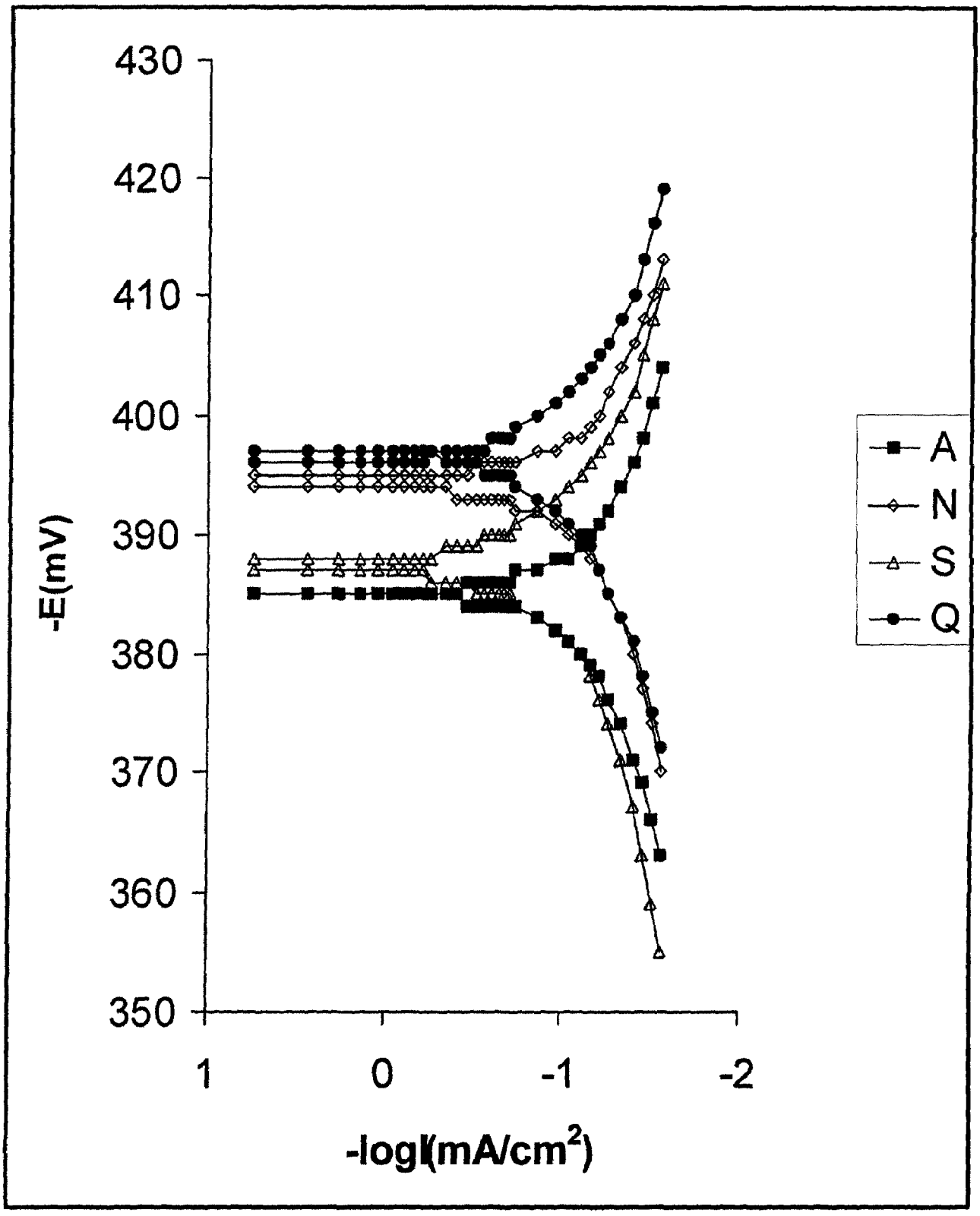
Fig(42):Tafle lines for L.C.V. steel samples in 0.5 M HNO_3 at 55 °C



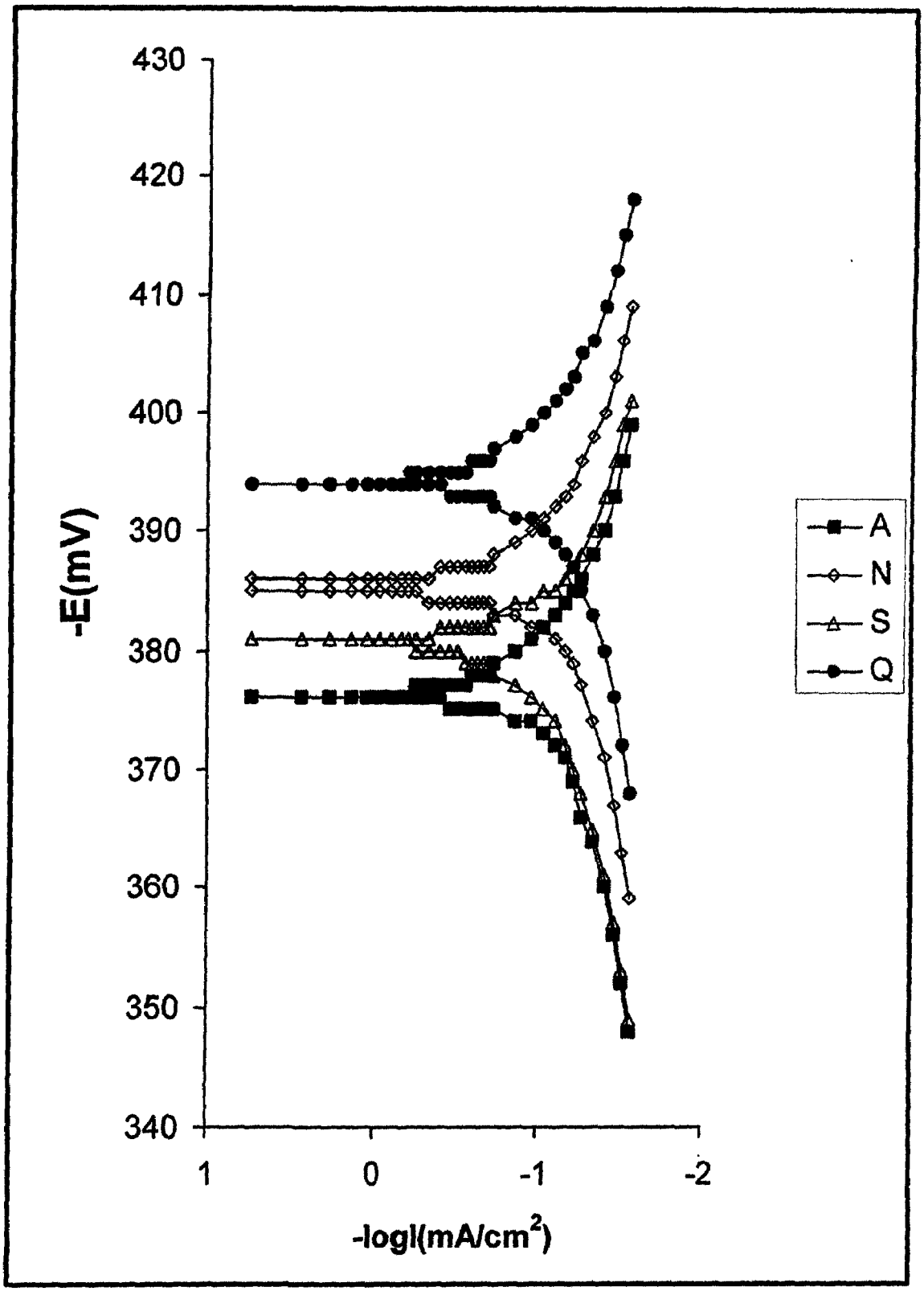
Fig(43):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 2 x10^{-5}M of HEAA at 55 °C



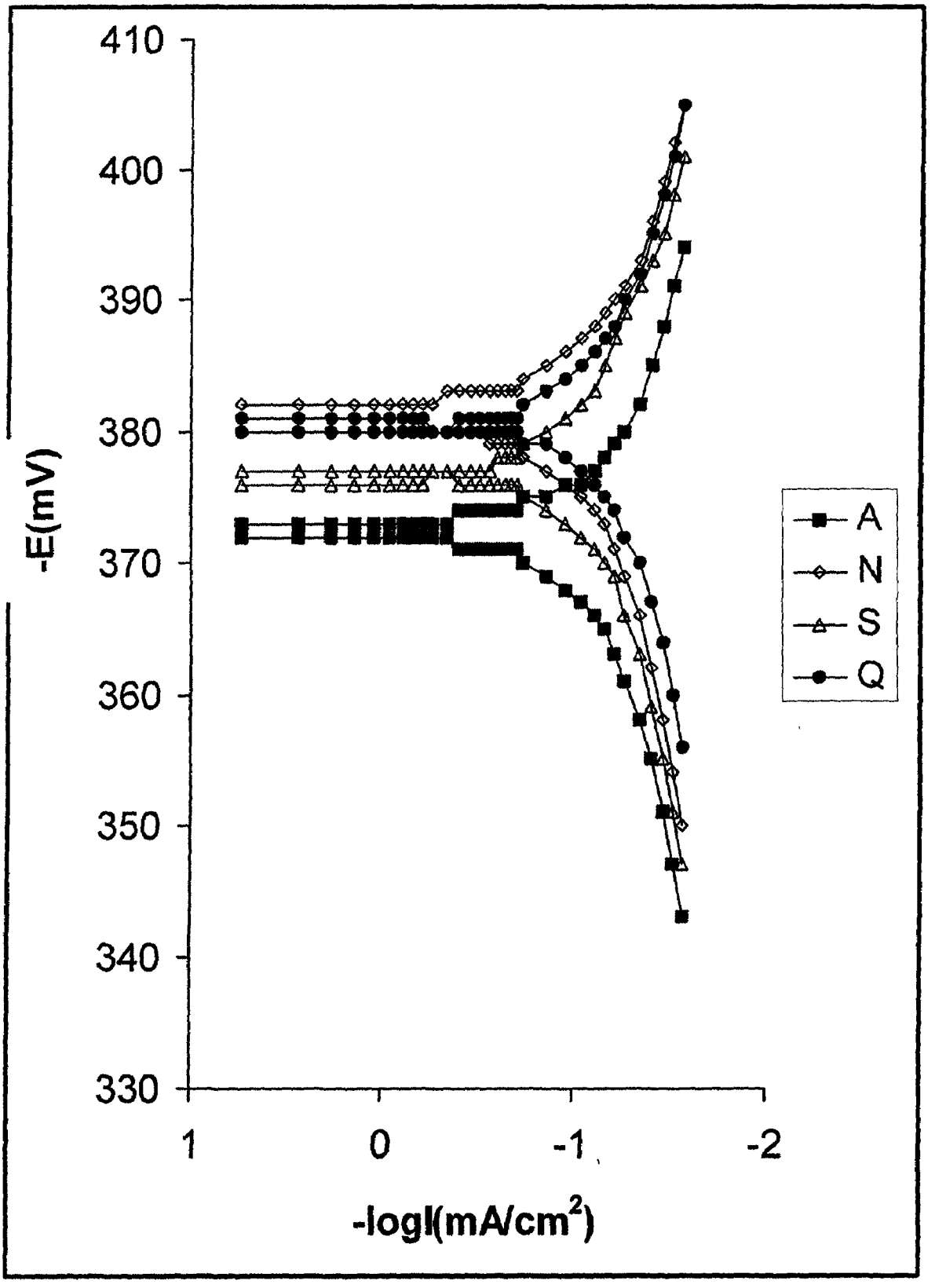
Fig(44):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 4 x10^{-5}M of HEAA at 55 °C



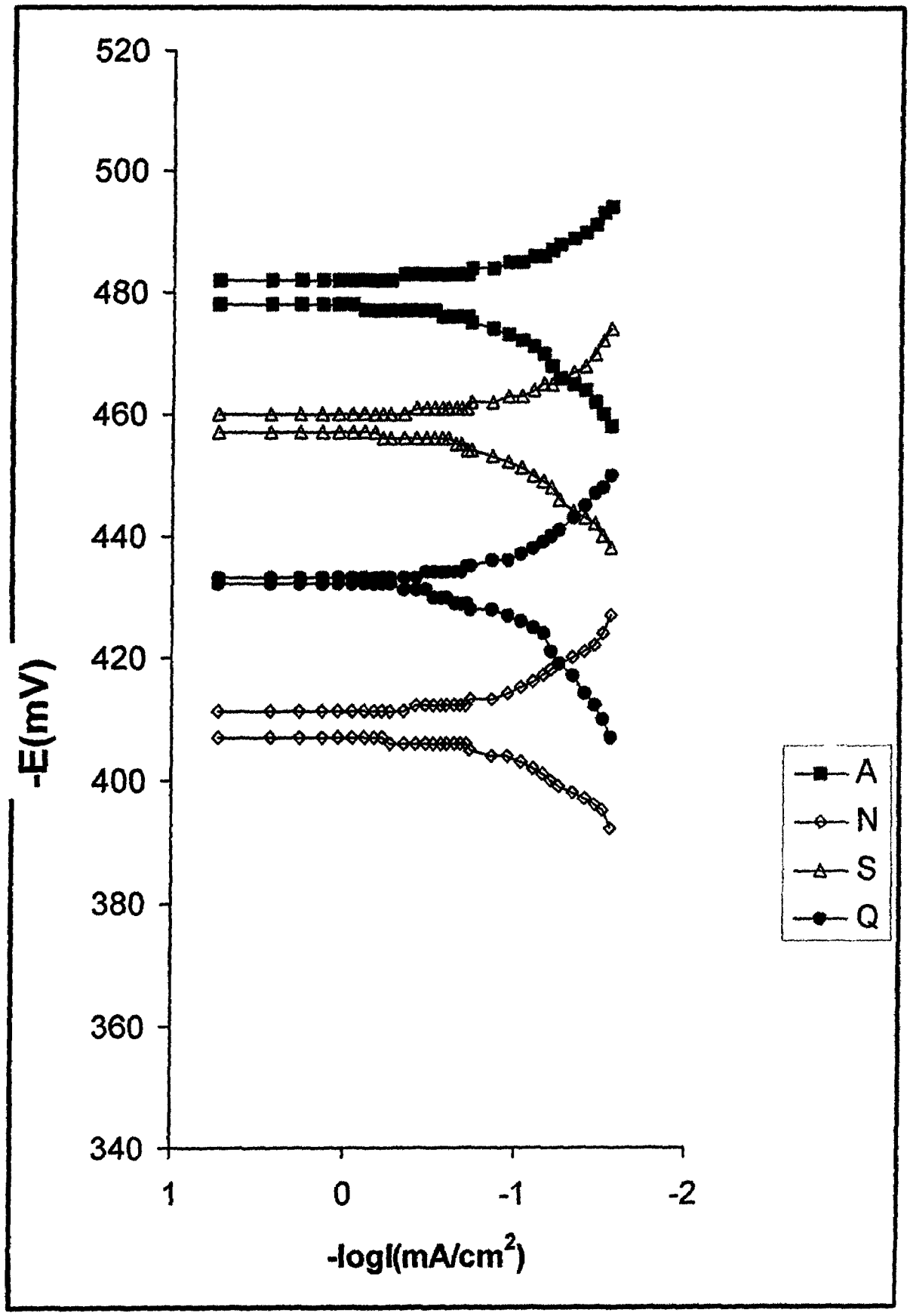
Fig(45):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 6 x10^{-5}M of HEAA at 55 °C



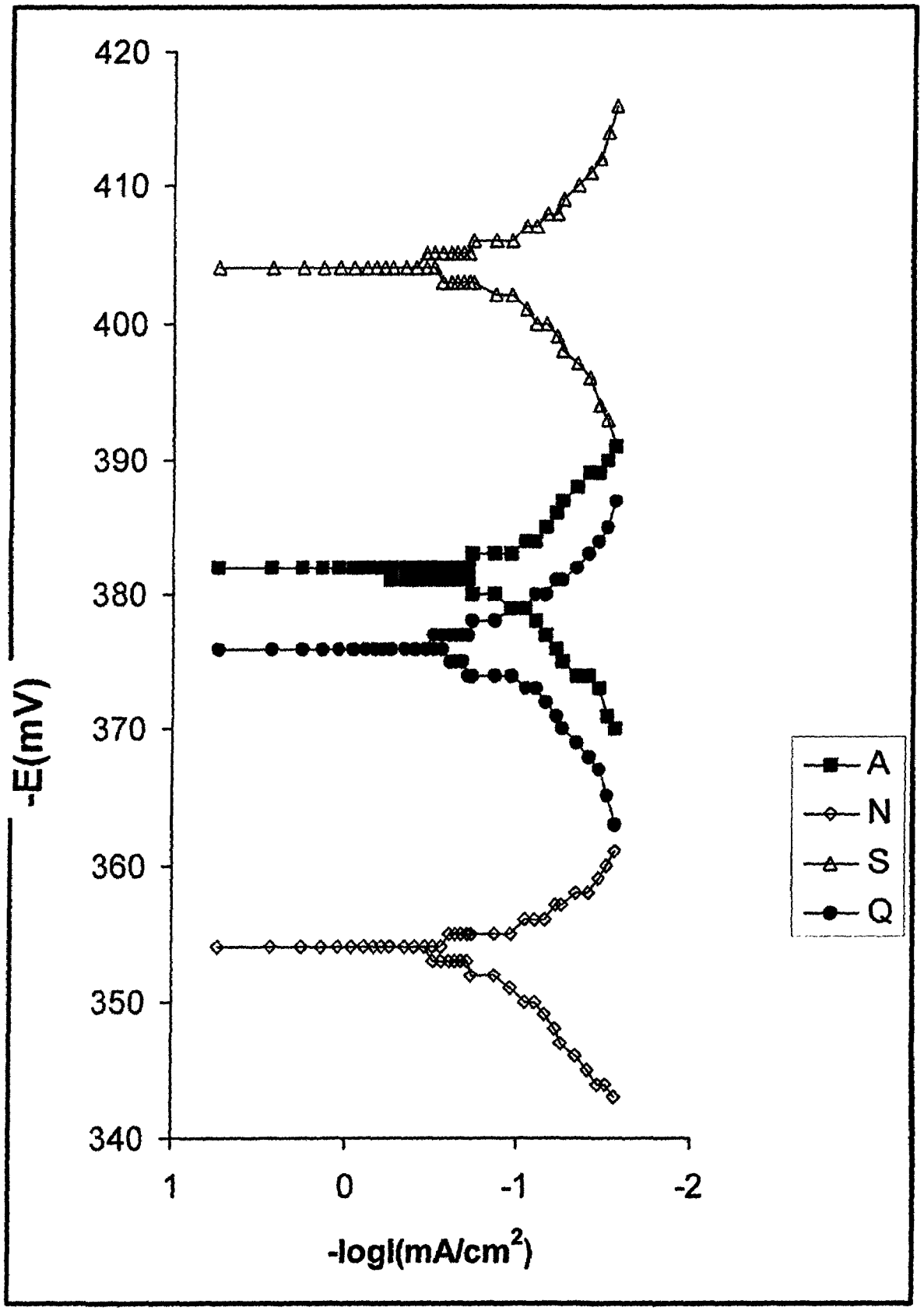
Fig(46):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 8 x10^{-5}M of HEAA at 55 °C



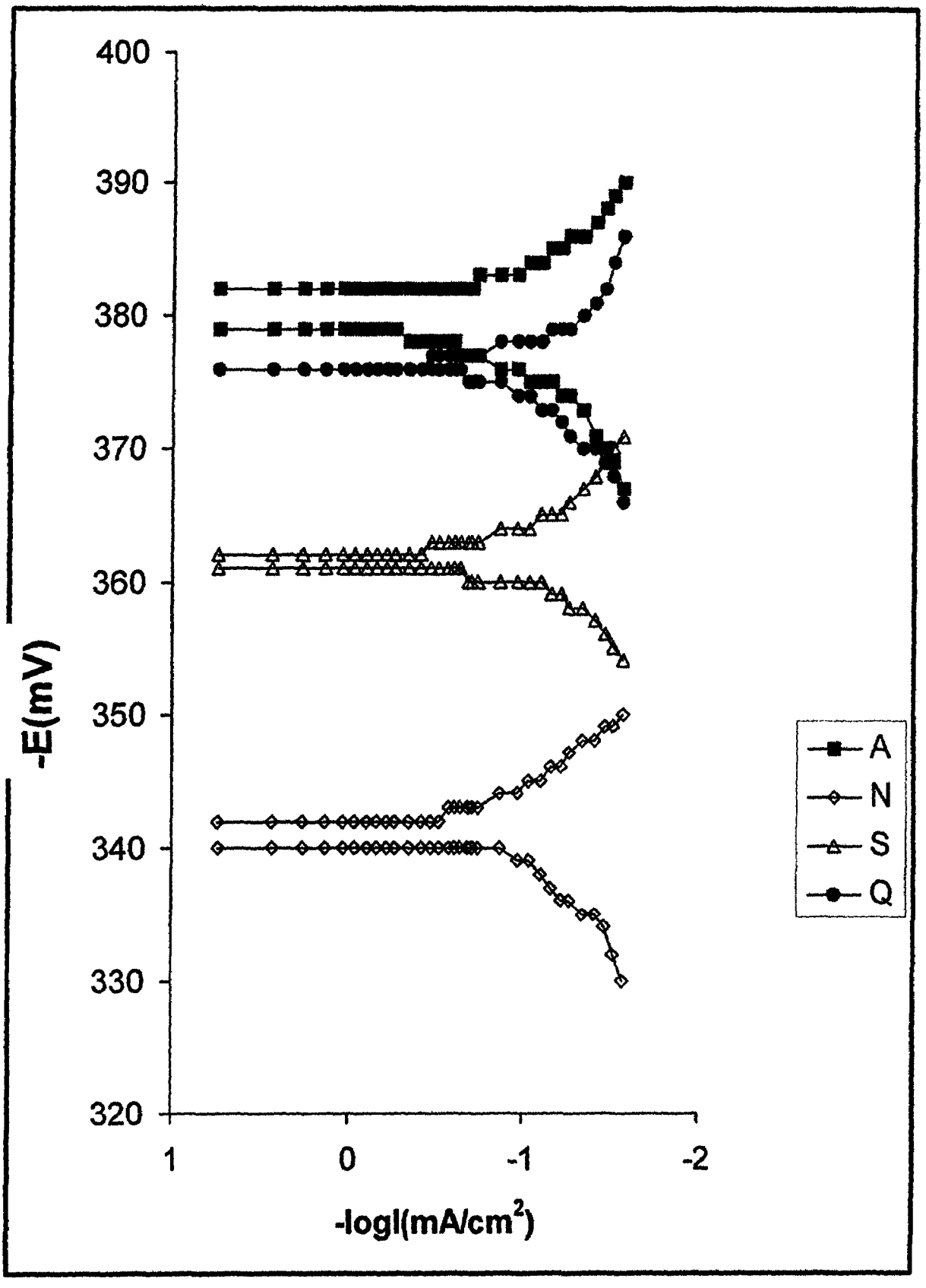
Fig(47):Tafle lines for L.C.V. steel samples in 0.1M HNO_3 and in presence of 10^{-4}M of HEAA at 55 °C



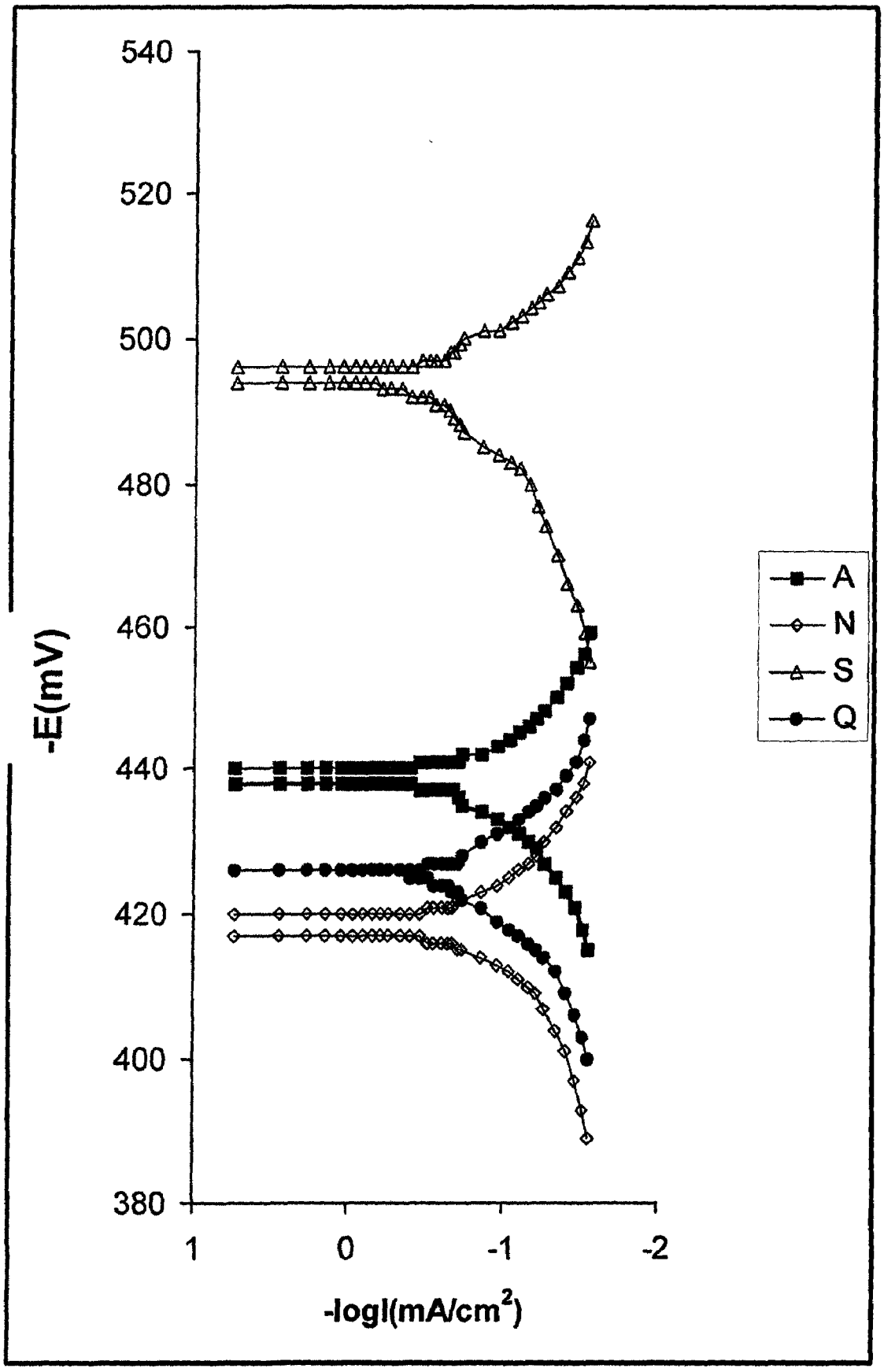
Fig(48):Tafle lines for M.C.V. steel samples in 0.1 M HNO_3 at 25 °C



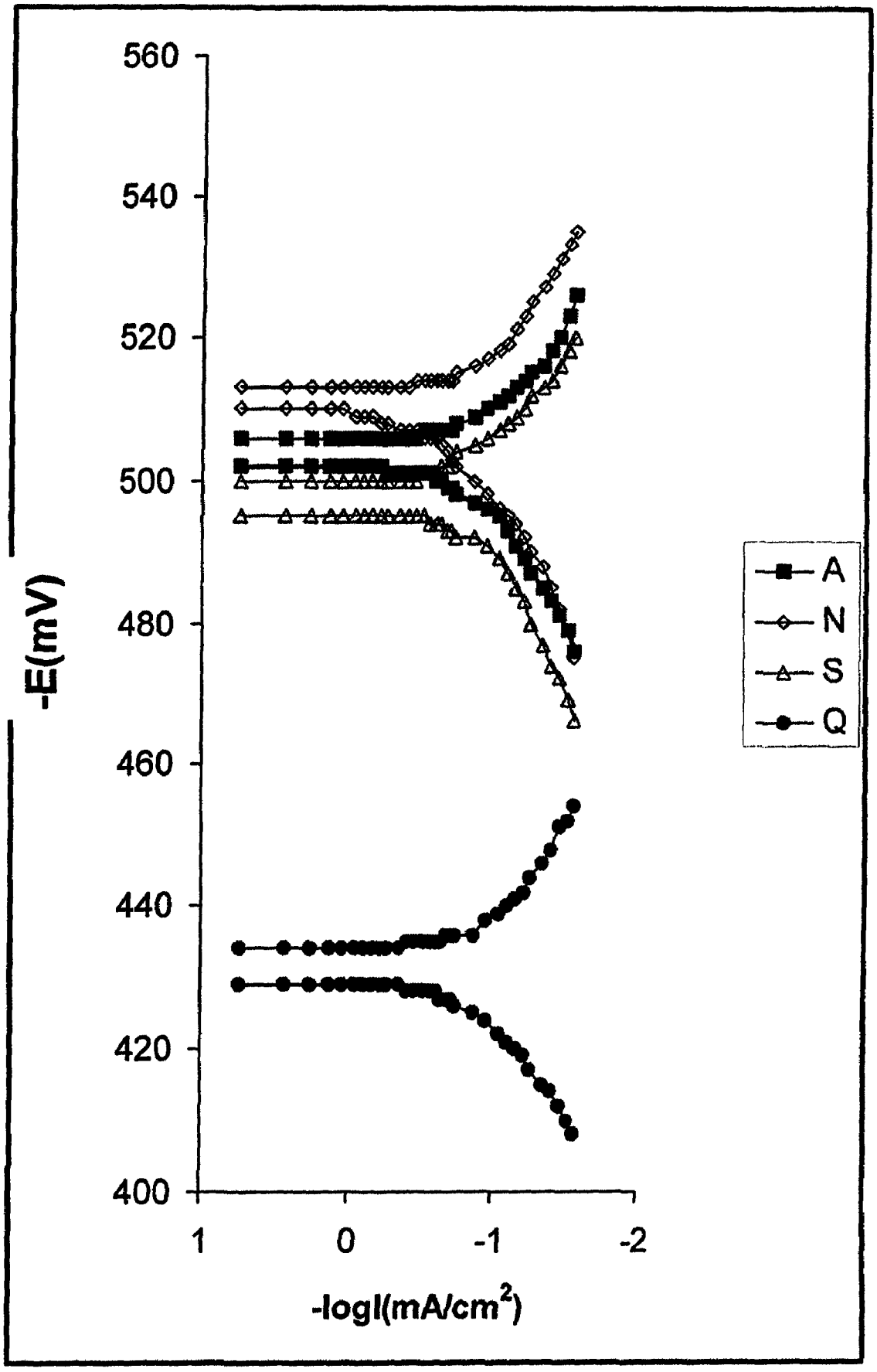
Fig(49):Tafle lines for M.C.V. steel samples in 0.3 M HNO_3 at 25°C



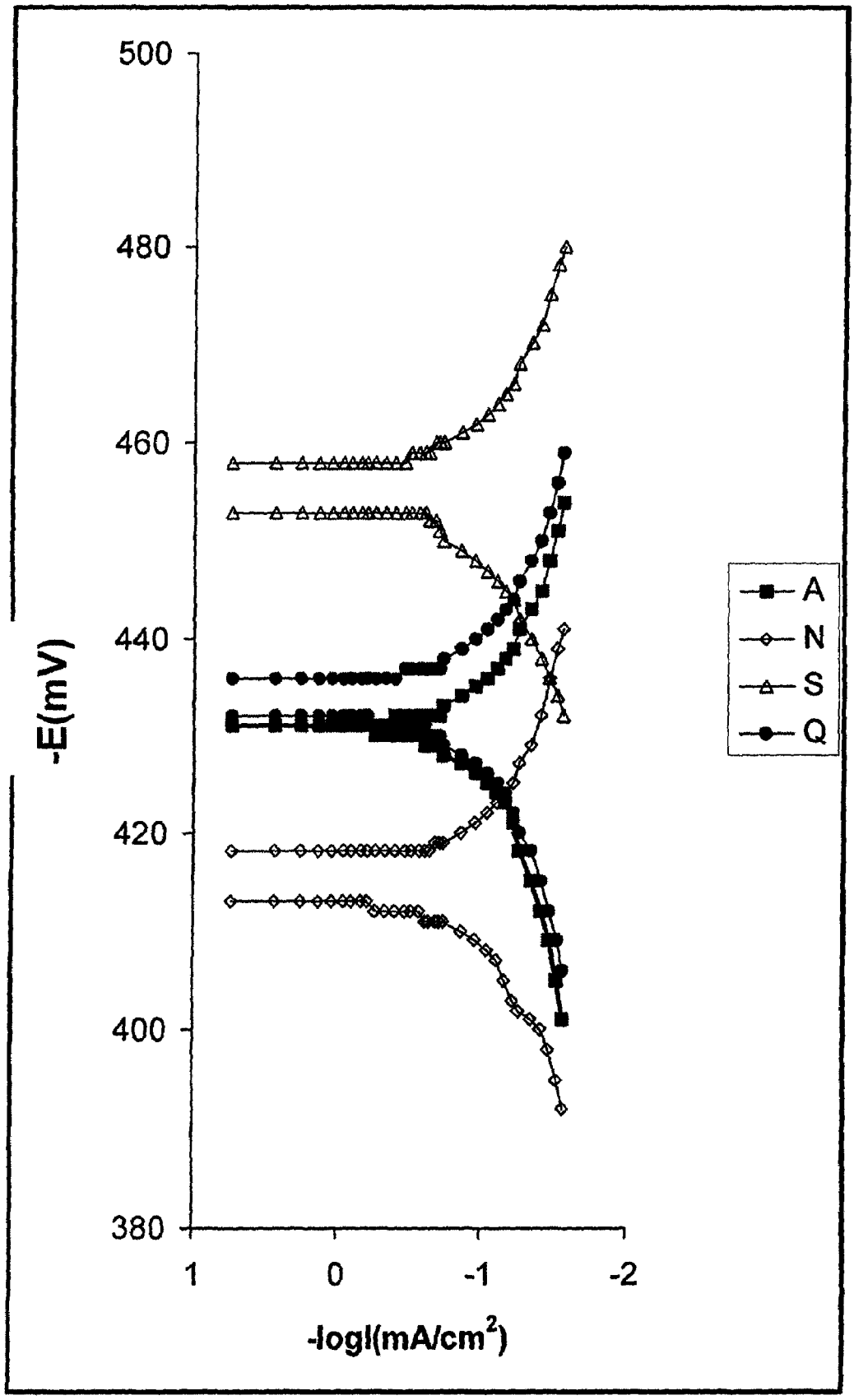
Fig(50):Tafle lines for M.C.V. steel samples in 0.5 M HNO_3 at 25°C



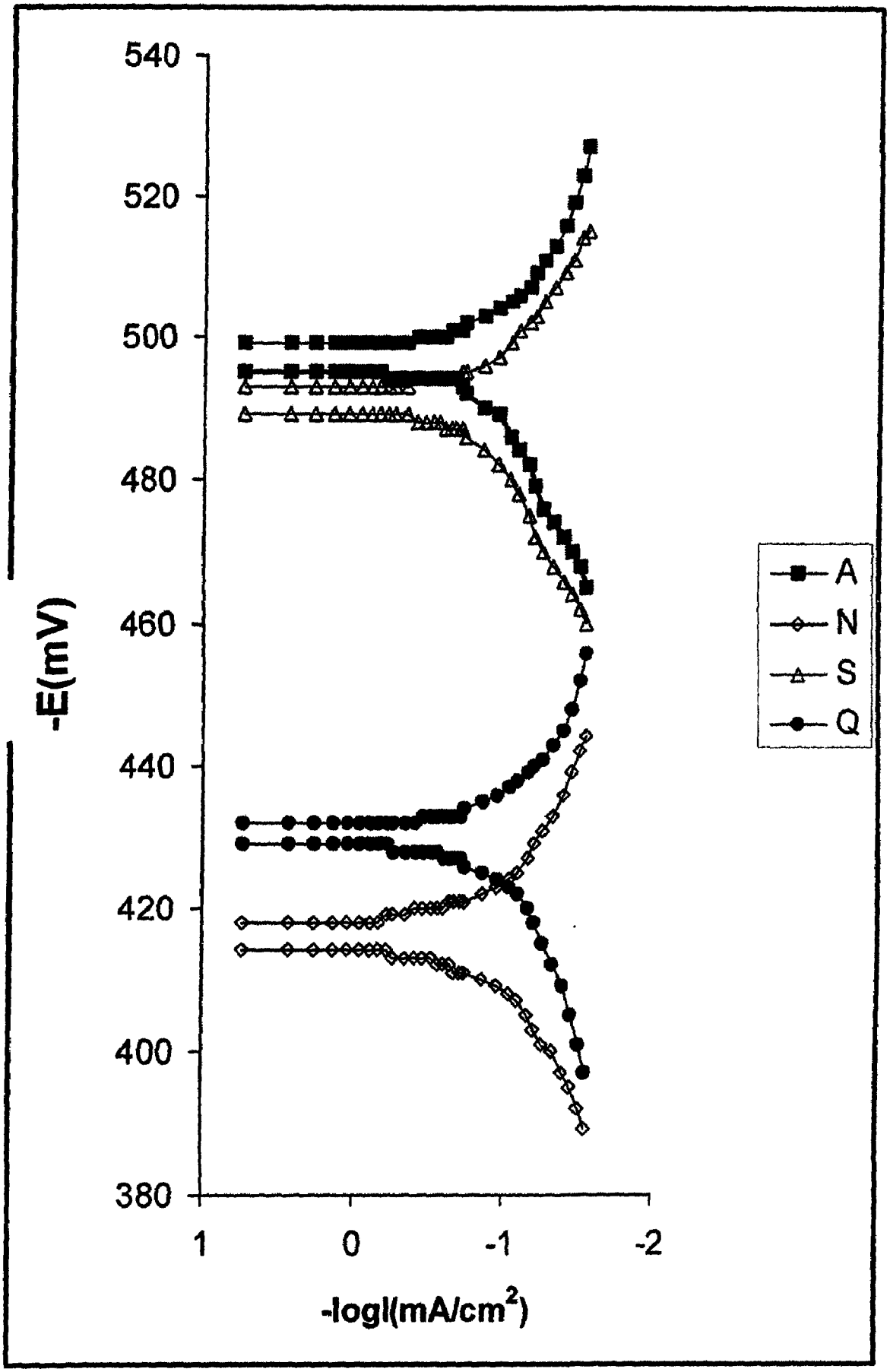
Fig(51):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 2 x10^{-5}M of HEAA at 25 °C



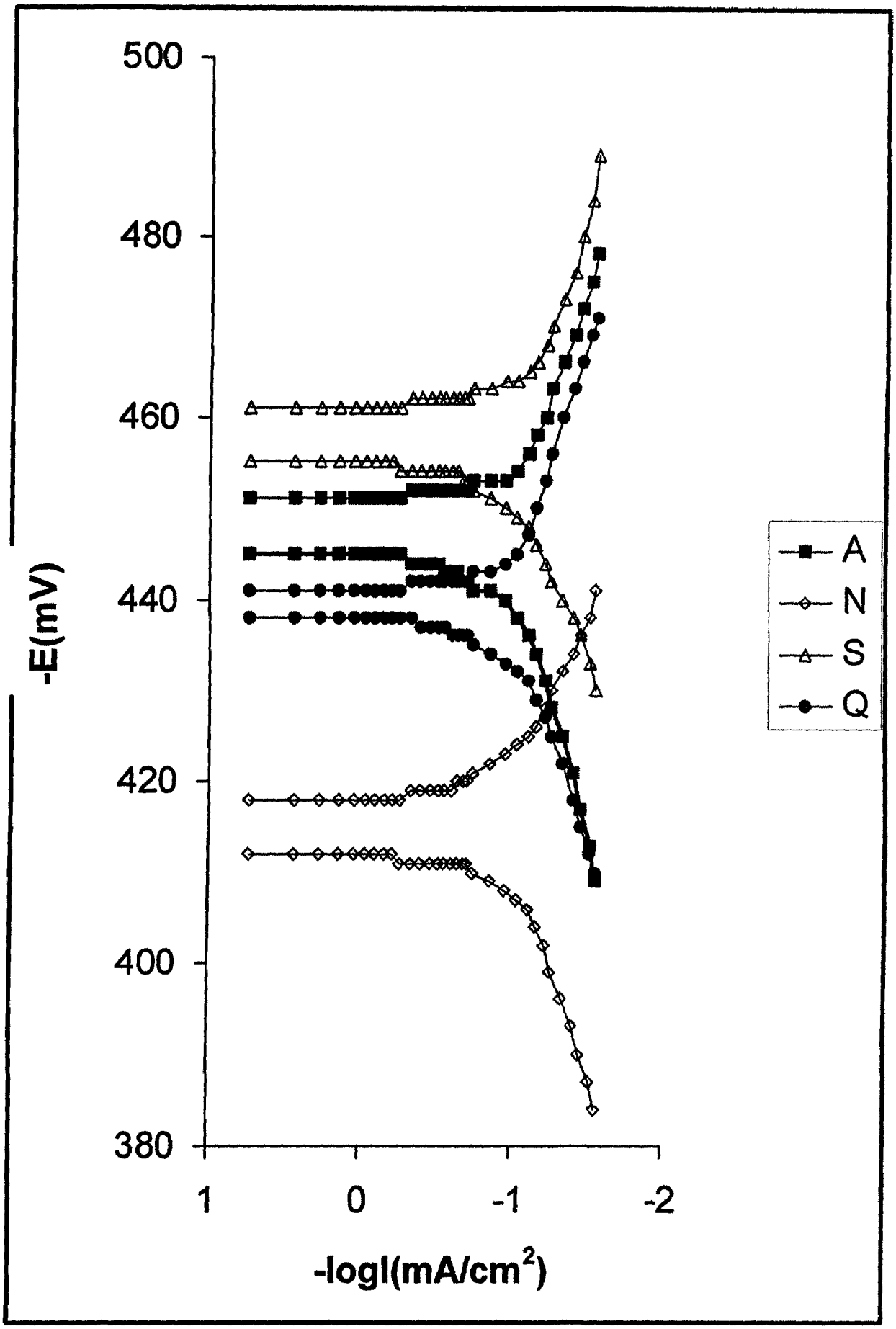
Fig(52):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 4 x10^{-5}M of HEAA at 25 °C



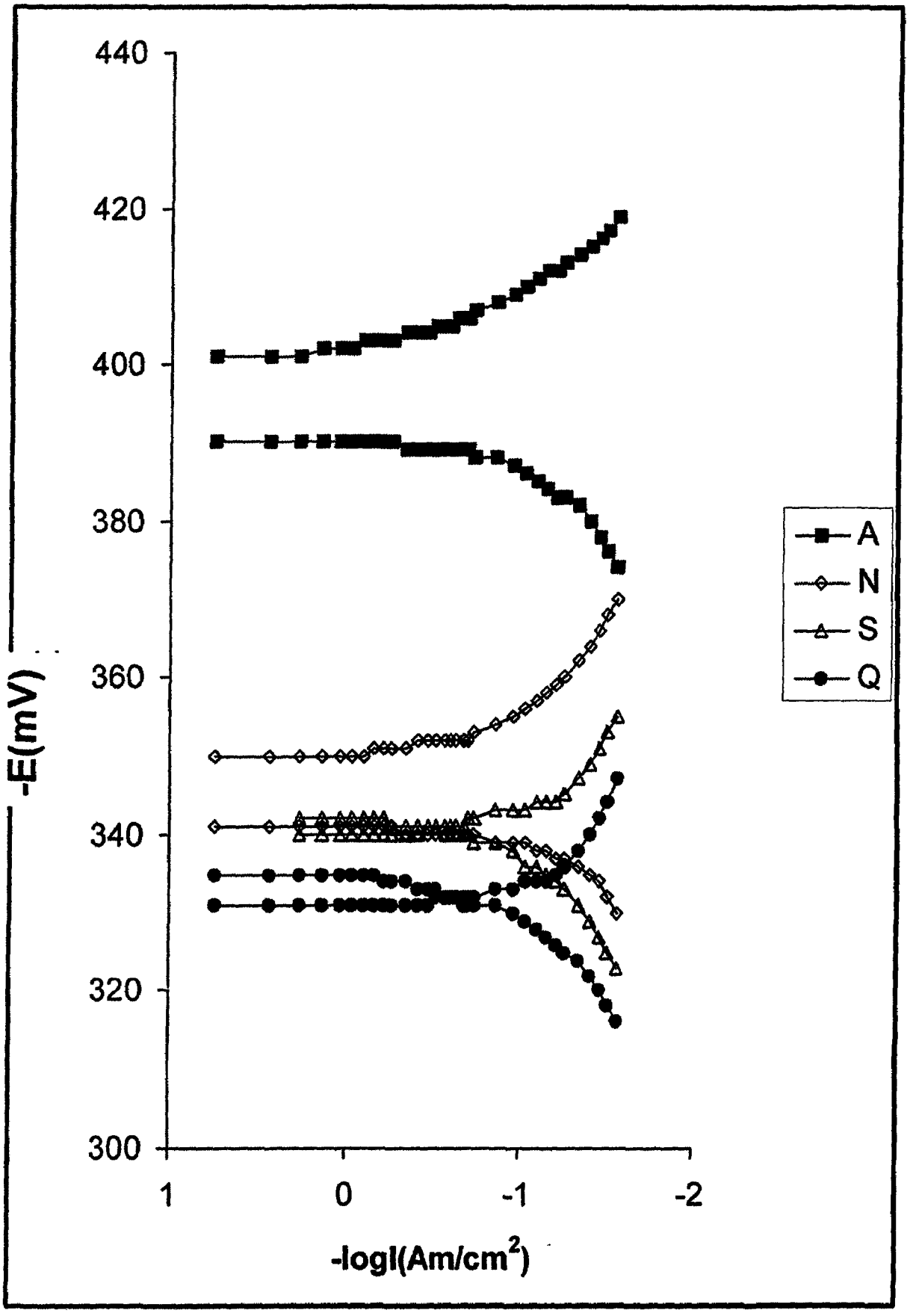
Fig(53):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 6 x10^{-5}M of HEAA at 25 °C



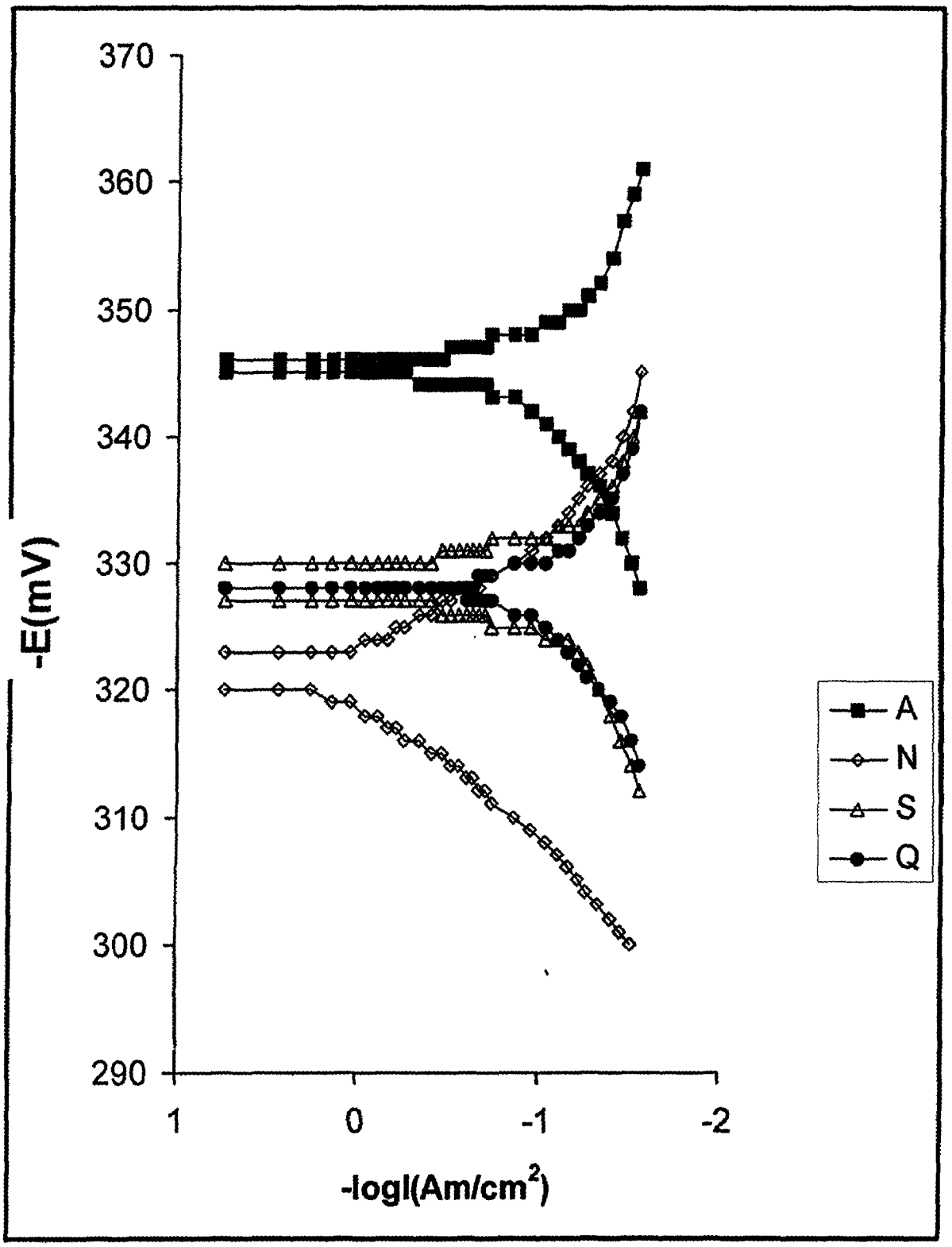
Fig(54):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 8 x10^{-5}M of HEAA at 25 °C



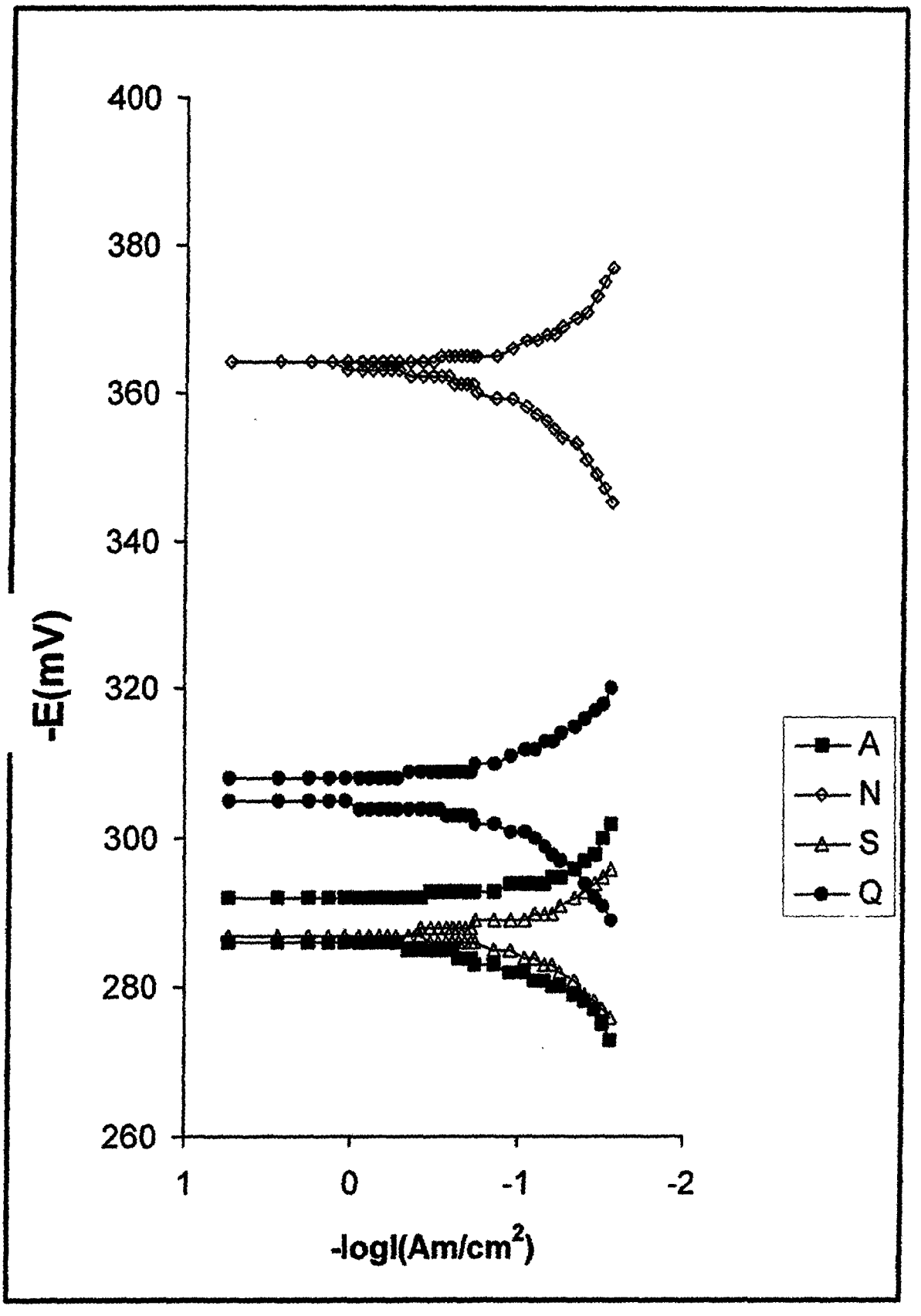
Fig(55):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 10^{-4}M of HEAA at 25 °C



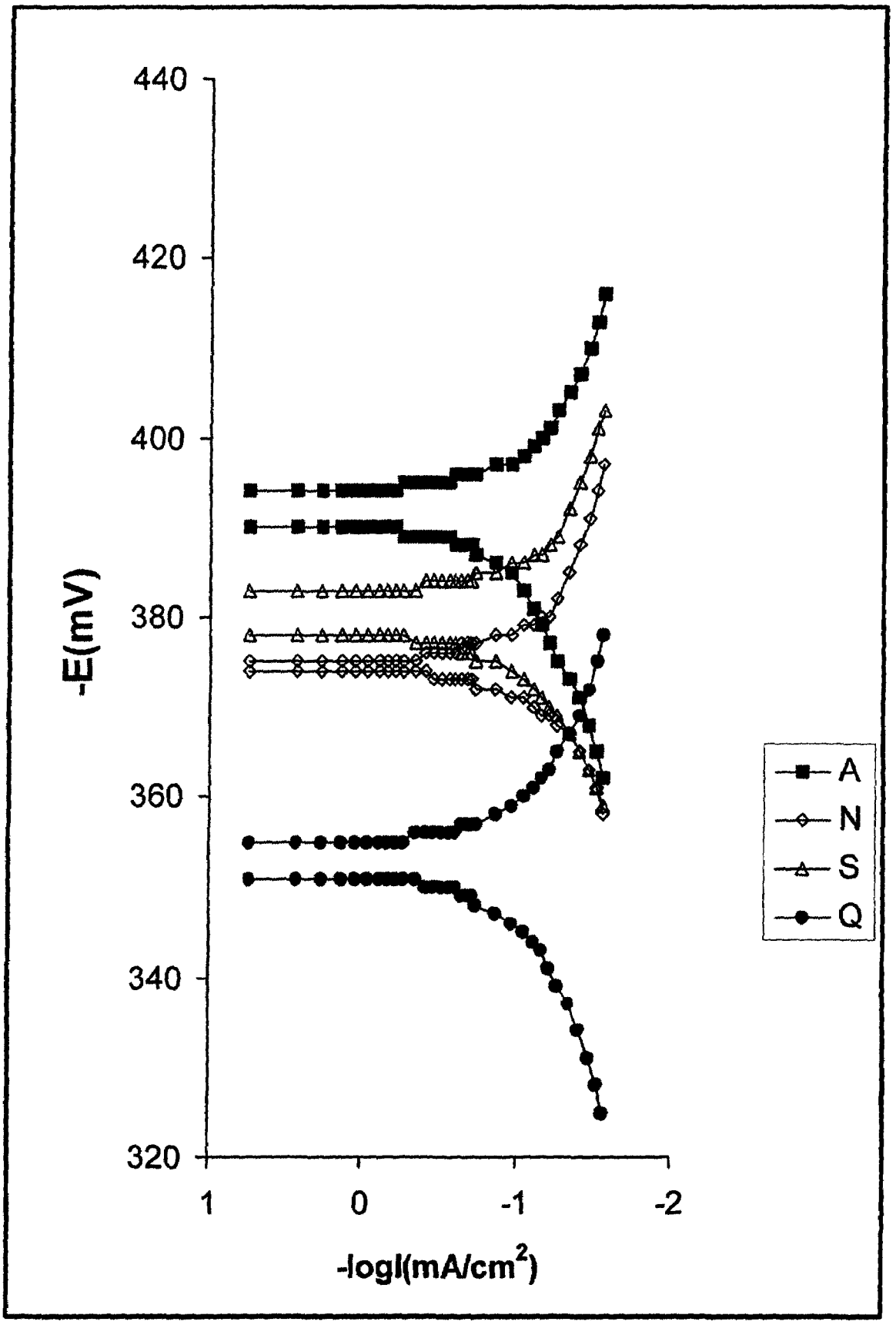
Fig(56):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 at 35 °C



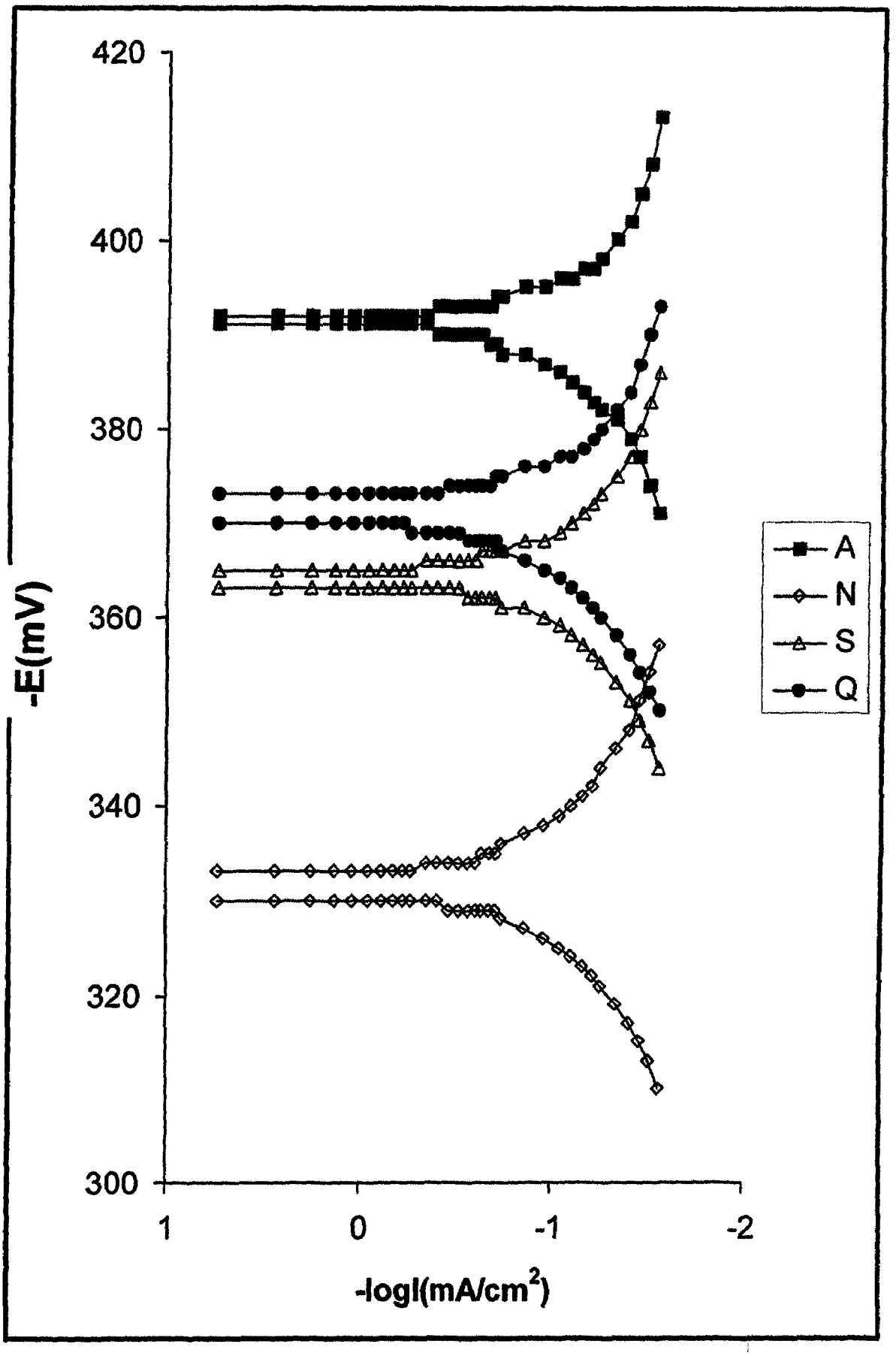
Fig(57):Tafle lines for M.C.V. steel samples in 0.3M HNO_3 at 35 °C



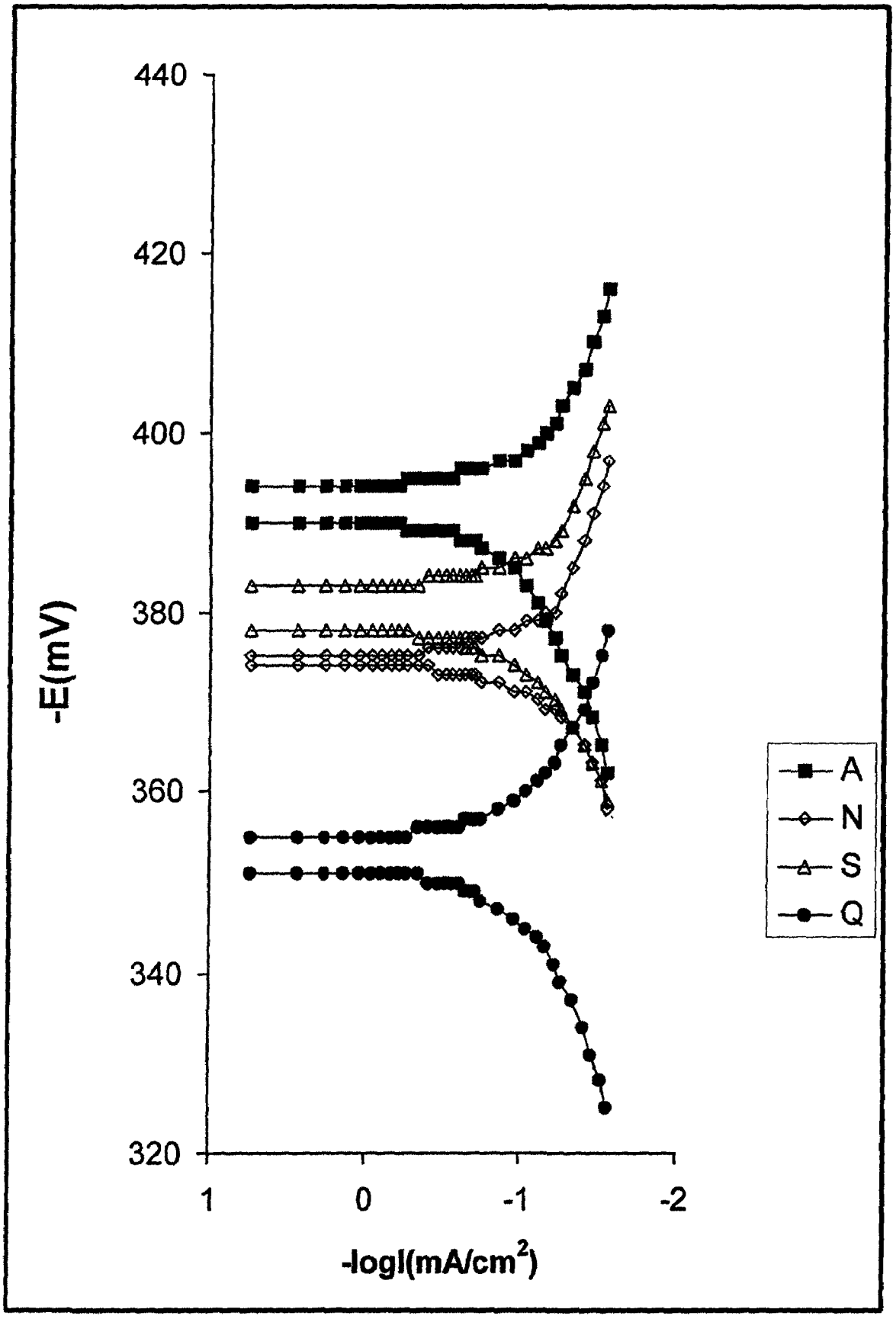
Fig(58):Tafle lines for M.C.V. steel samples in 0.5M HNO_3 at 35 °C



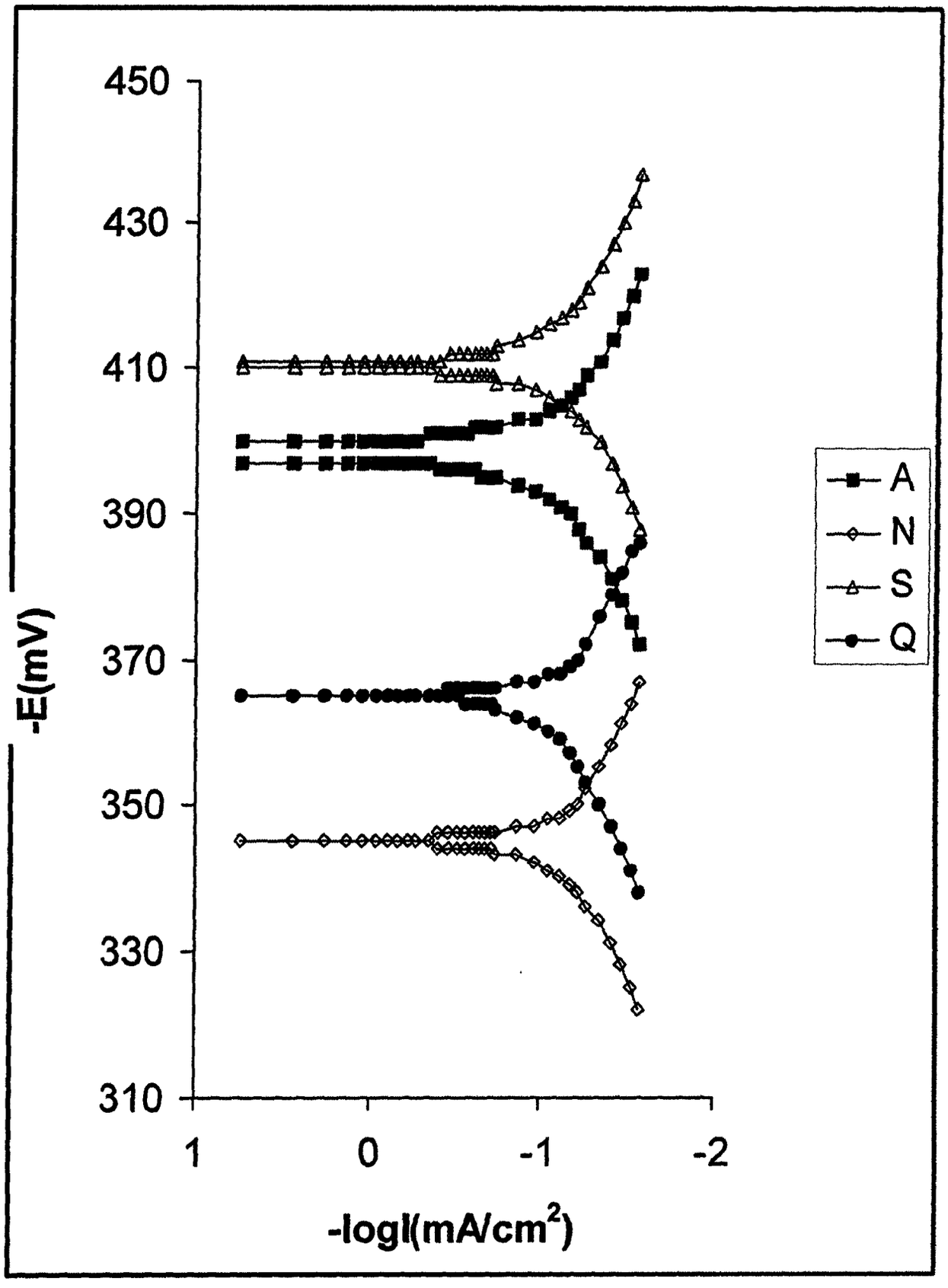
Fig(59):Tafle lines for M.C.V. steel samples in 0.1 M HNO_3 in presence of 2 x10^{-5}M of HEAA at 35 °C



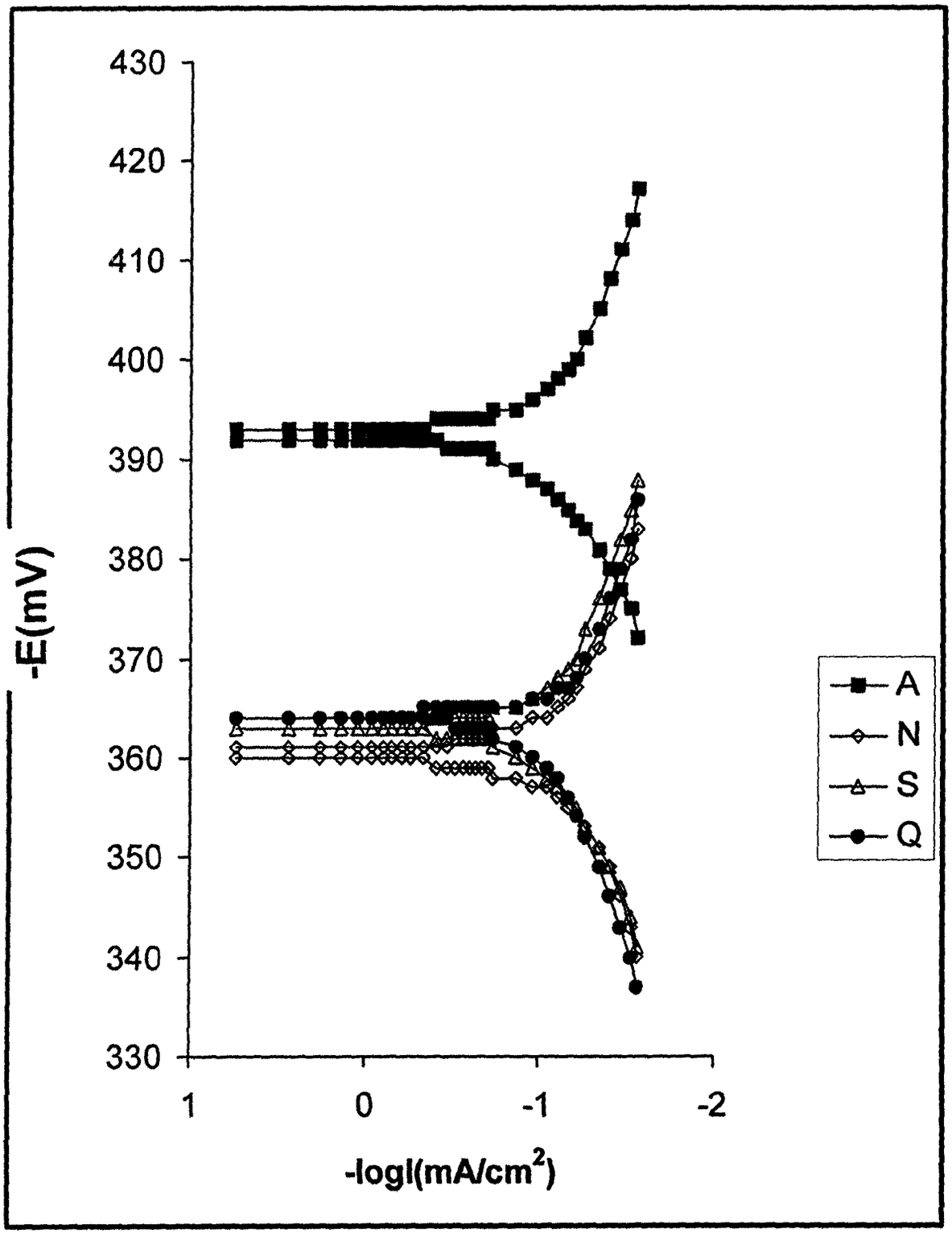
Fig(60):Tafle lines for M.C.V. steel samples in 0.1 M HNO_3 in presence of 4 x10^{-5}M of HEAA at 35 °C



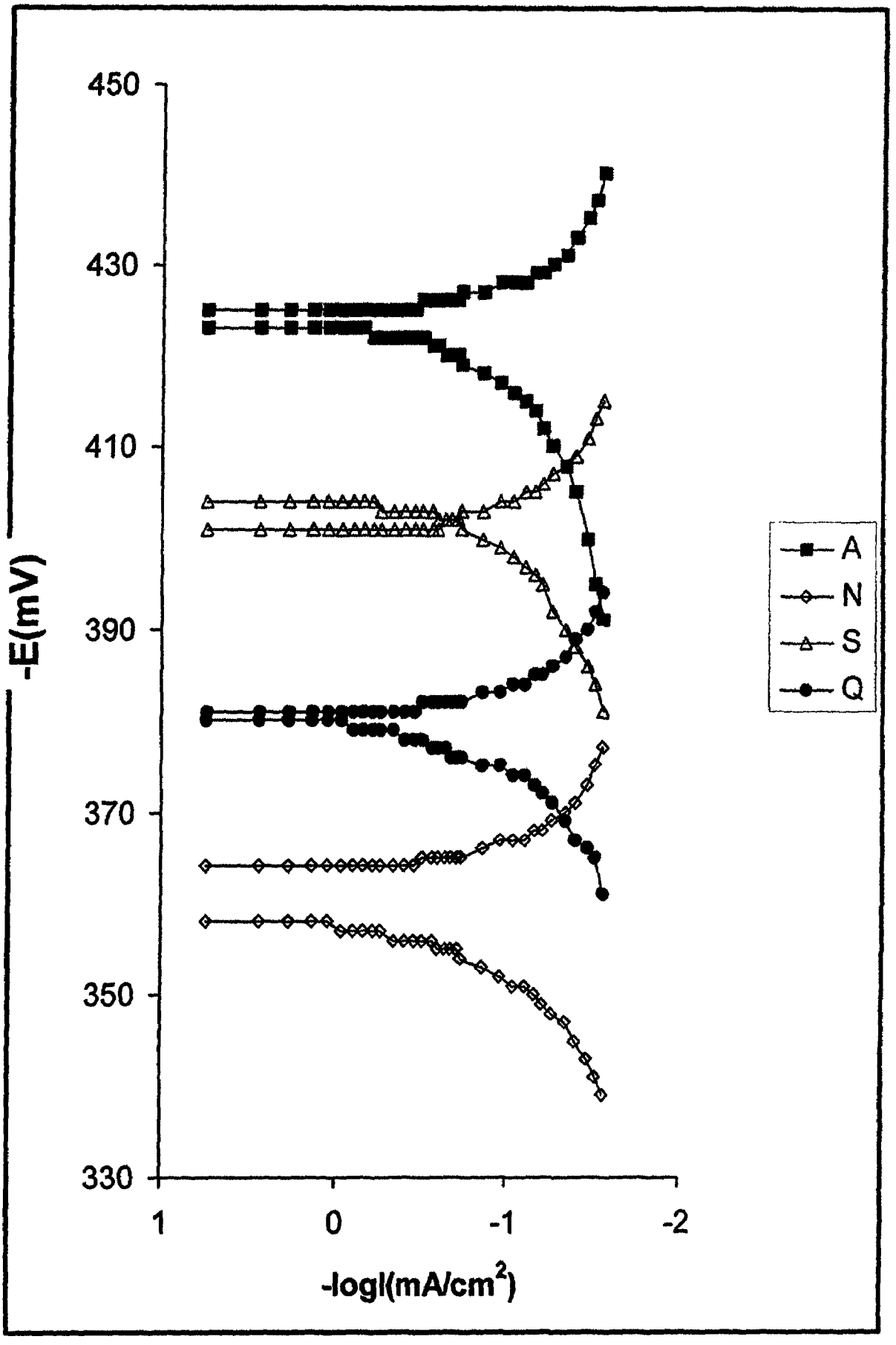
Fig(61):Tafle lines for M.C.V. steel samples in 0.1 M HNO_3 in presence of 6 x10^{-5}M of HEAA at 35 °C



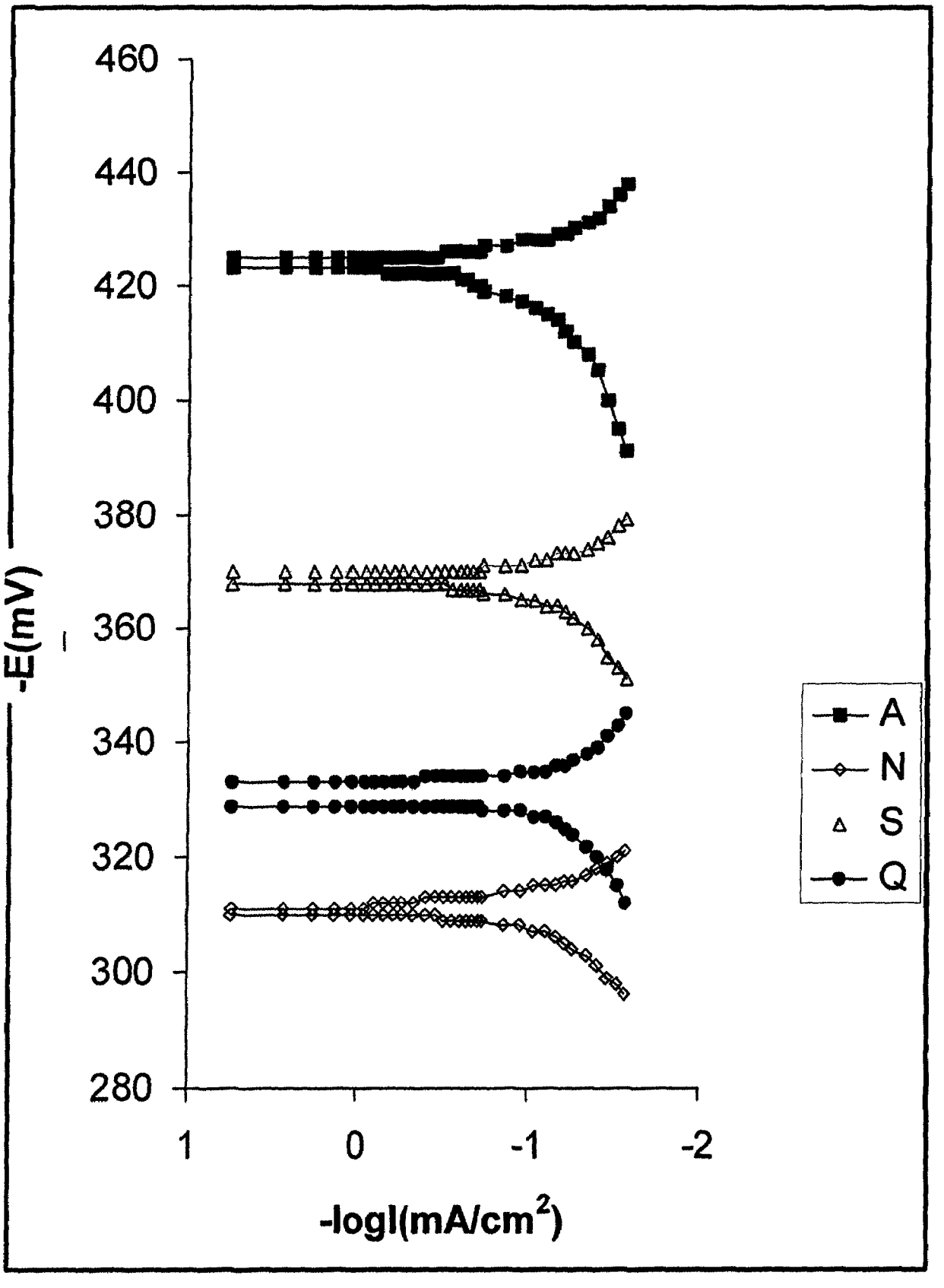
Fig(62):Tafle lines for M.C.V. steel samples in 0.1 M HNO_3 in presence of 8 x10^{-5}M of HEAA at 35 °C



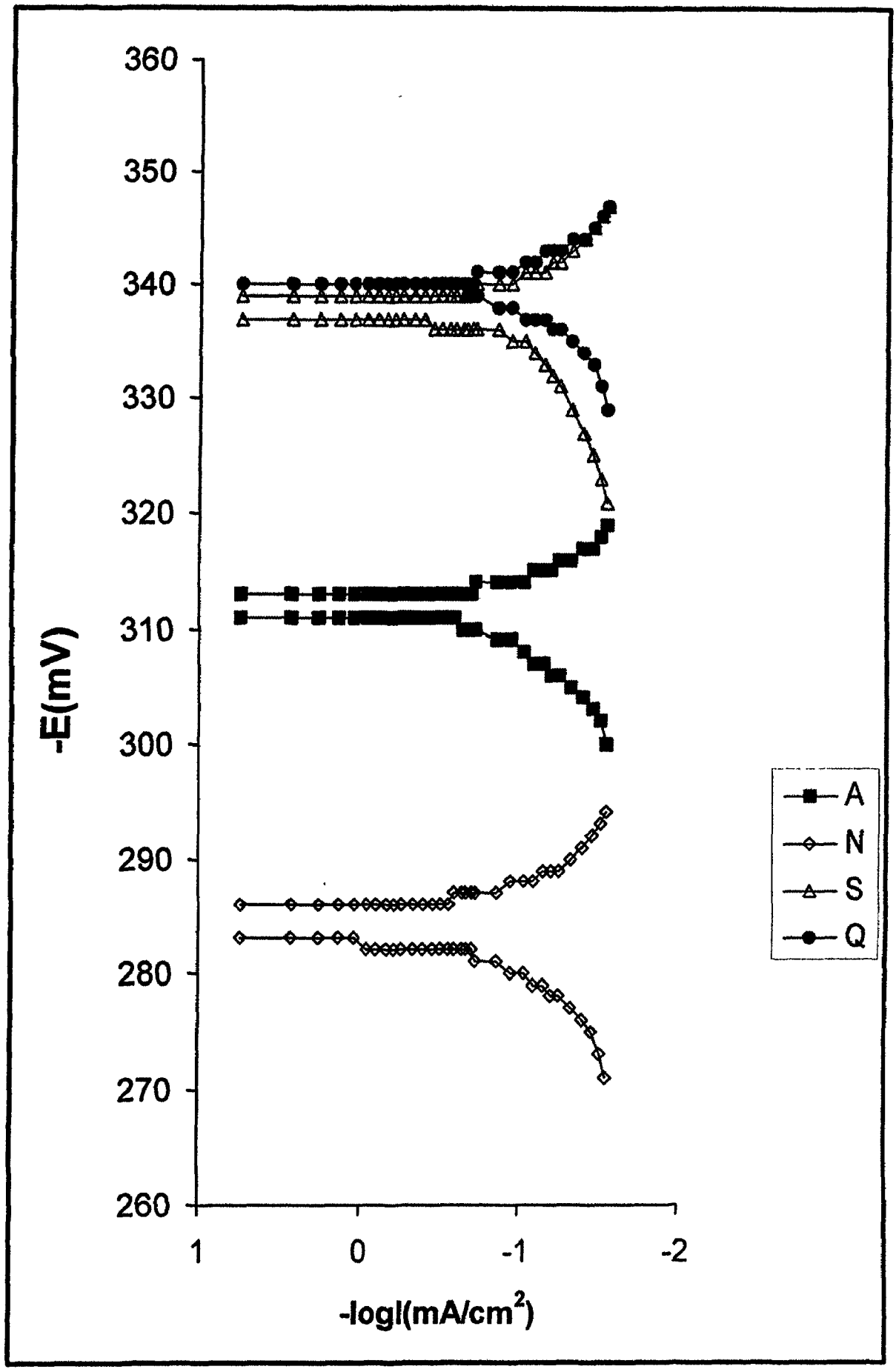
Fig(63):Tafle lines for M.C.V. steel samples in 0.1 M HNO_3 in presence of 10^{-4}M of HEAA at 35 °C



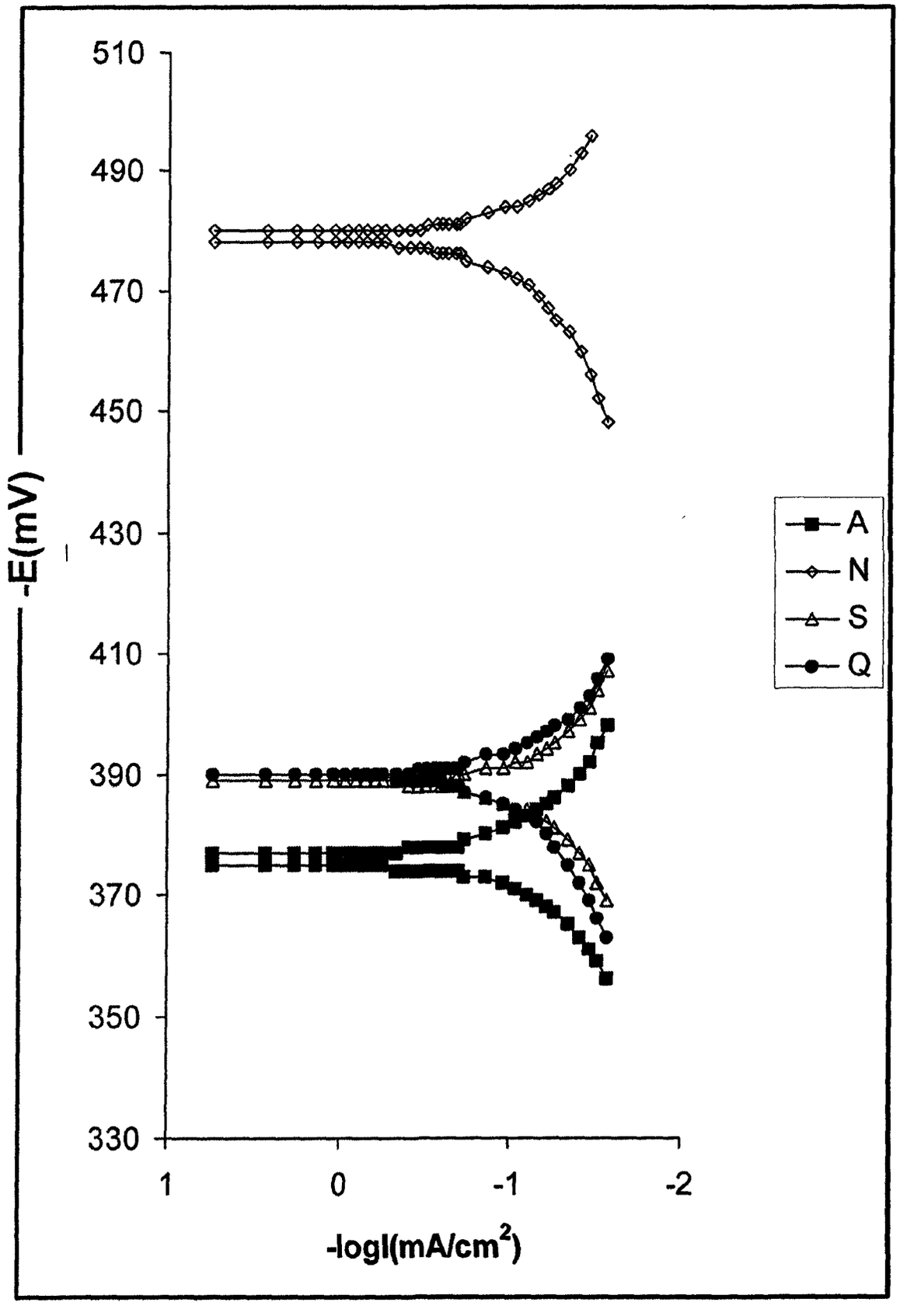
Fig(64):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 at 45°C



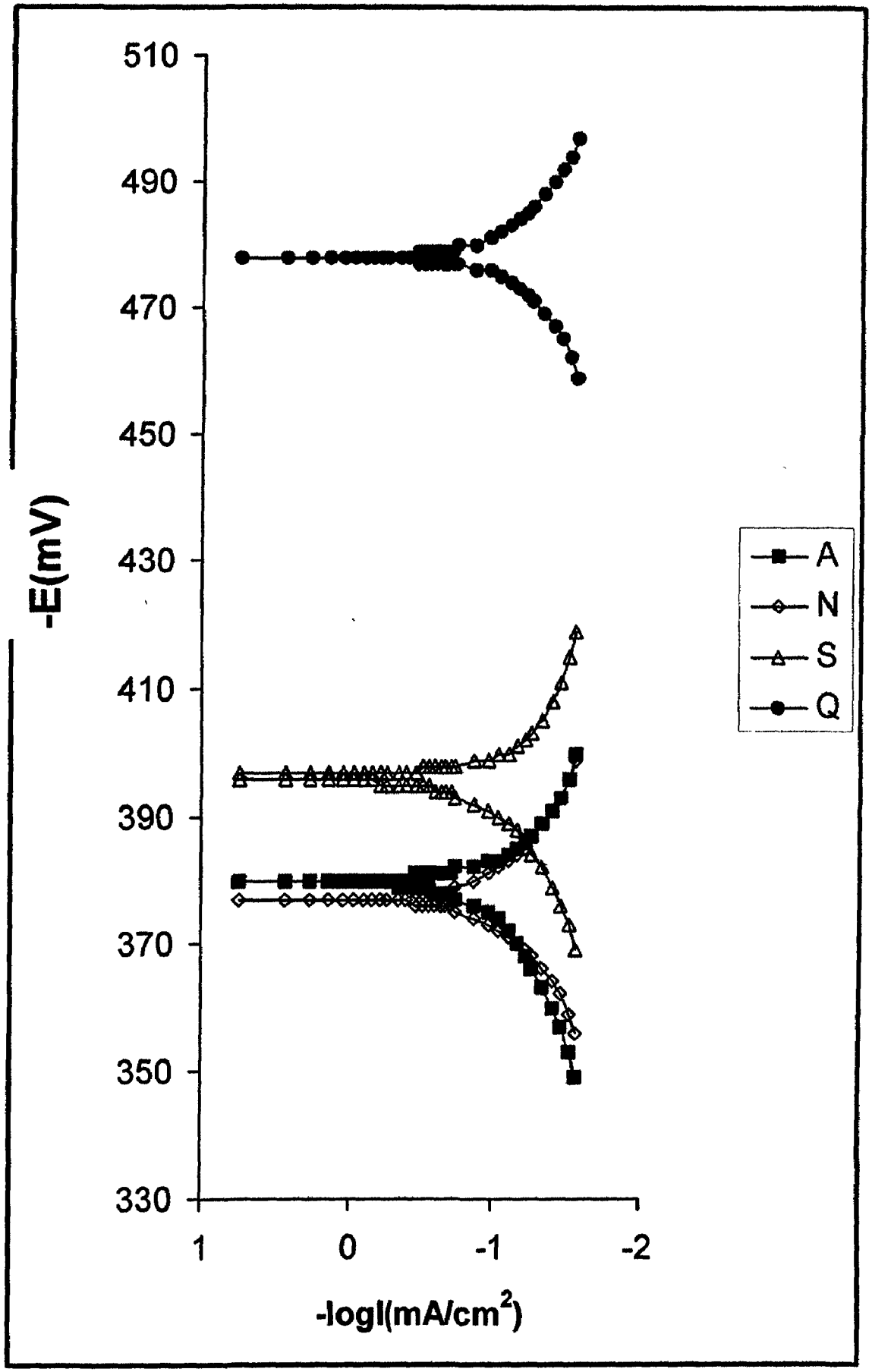
Fig(65):Tafle lines for M.C.V. steel samples in 0.3M HNO_3 at 45°C



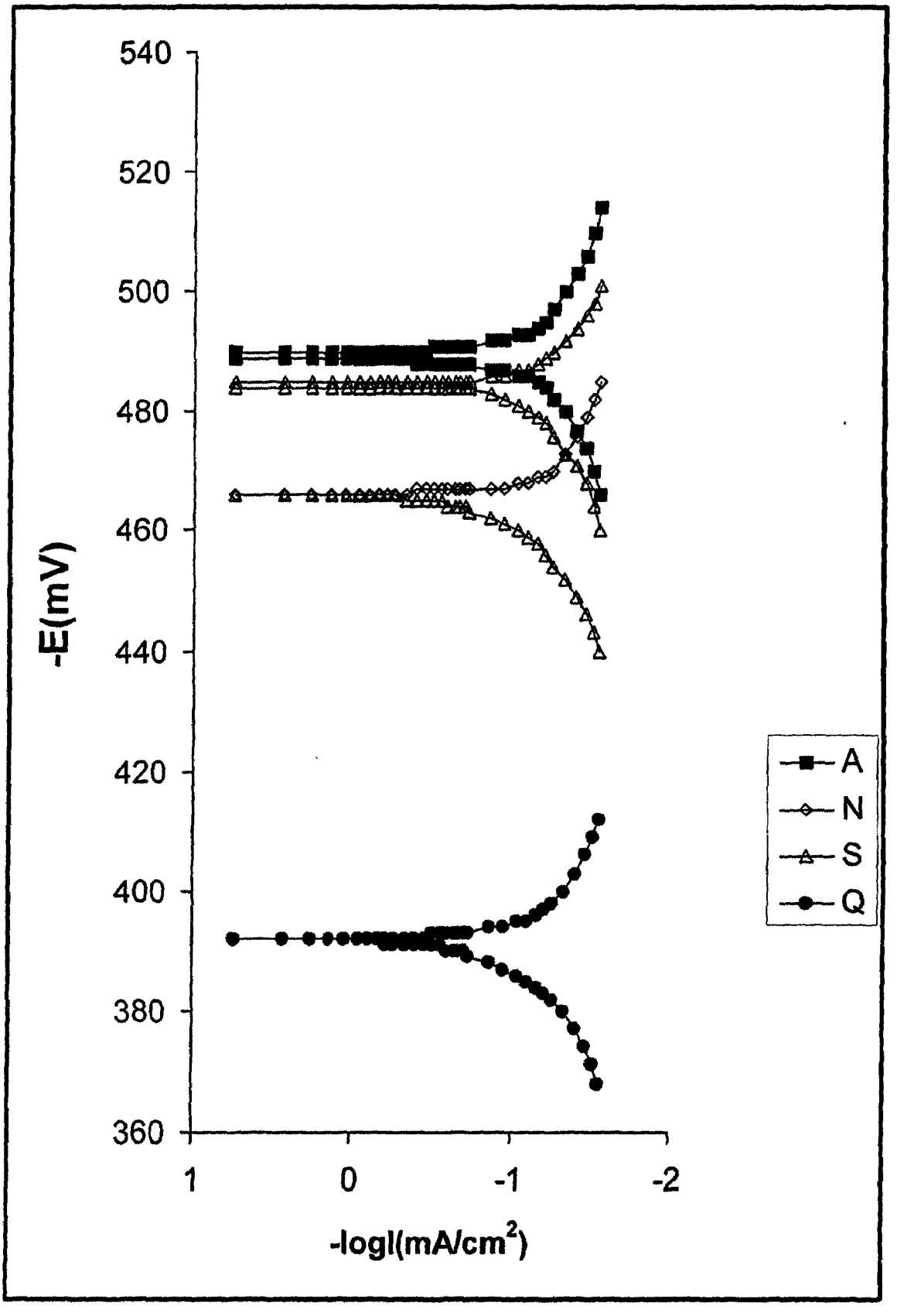
Fig(66):Tafle lines for M.C.V. steel samples in 0.5M HNO_3 at 45°C



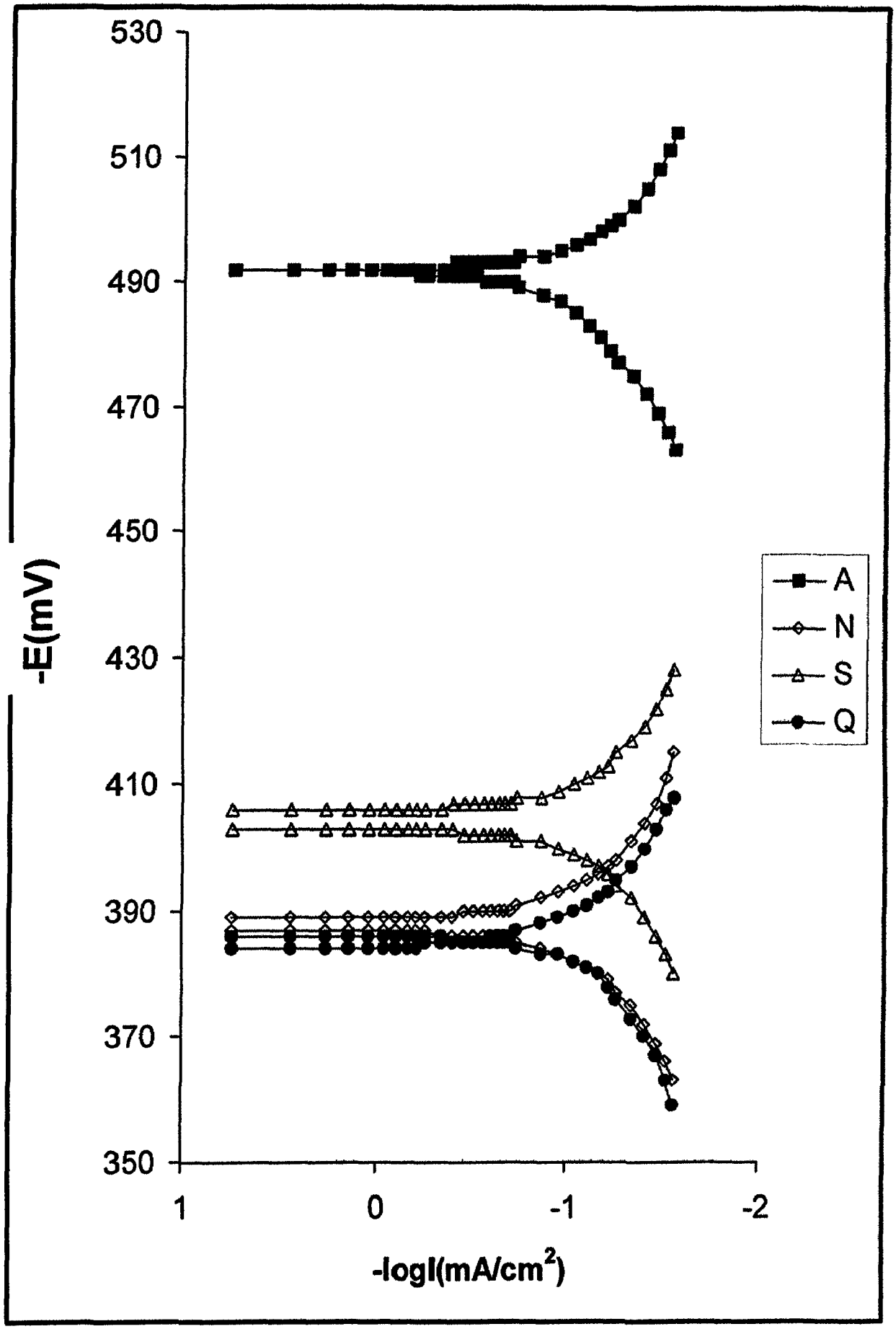
Fig(67):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of $2x10^{-5}$M of HEAA at 45 °C



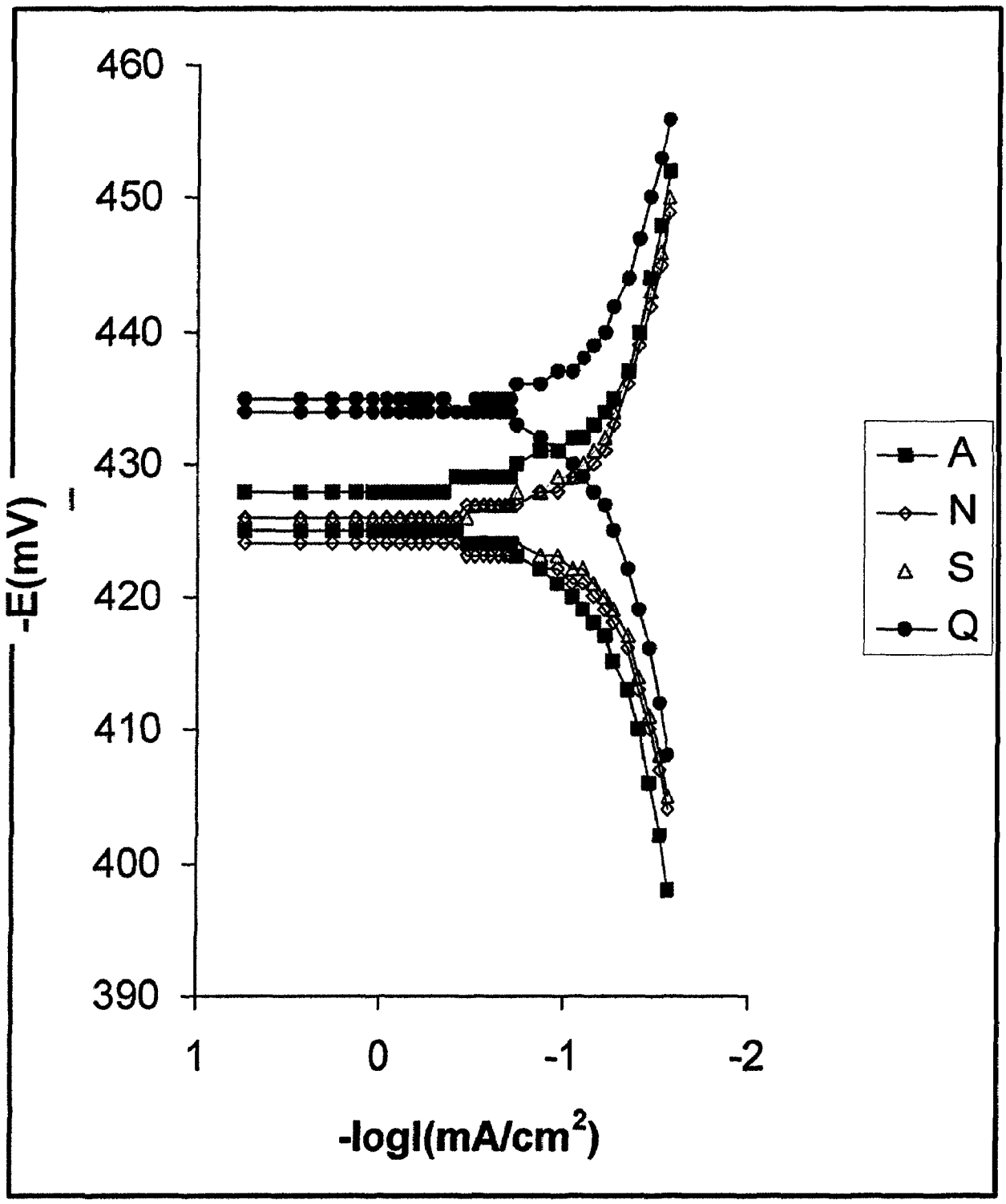
Fig(68):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of$4x10^{-5}$M of HEAA at 45 °C



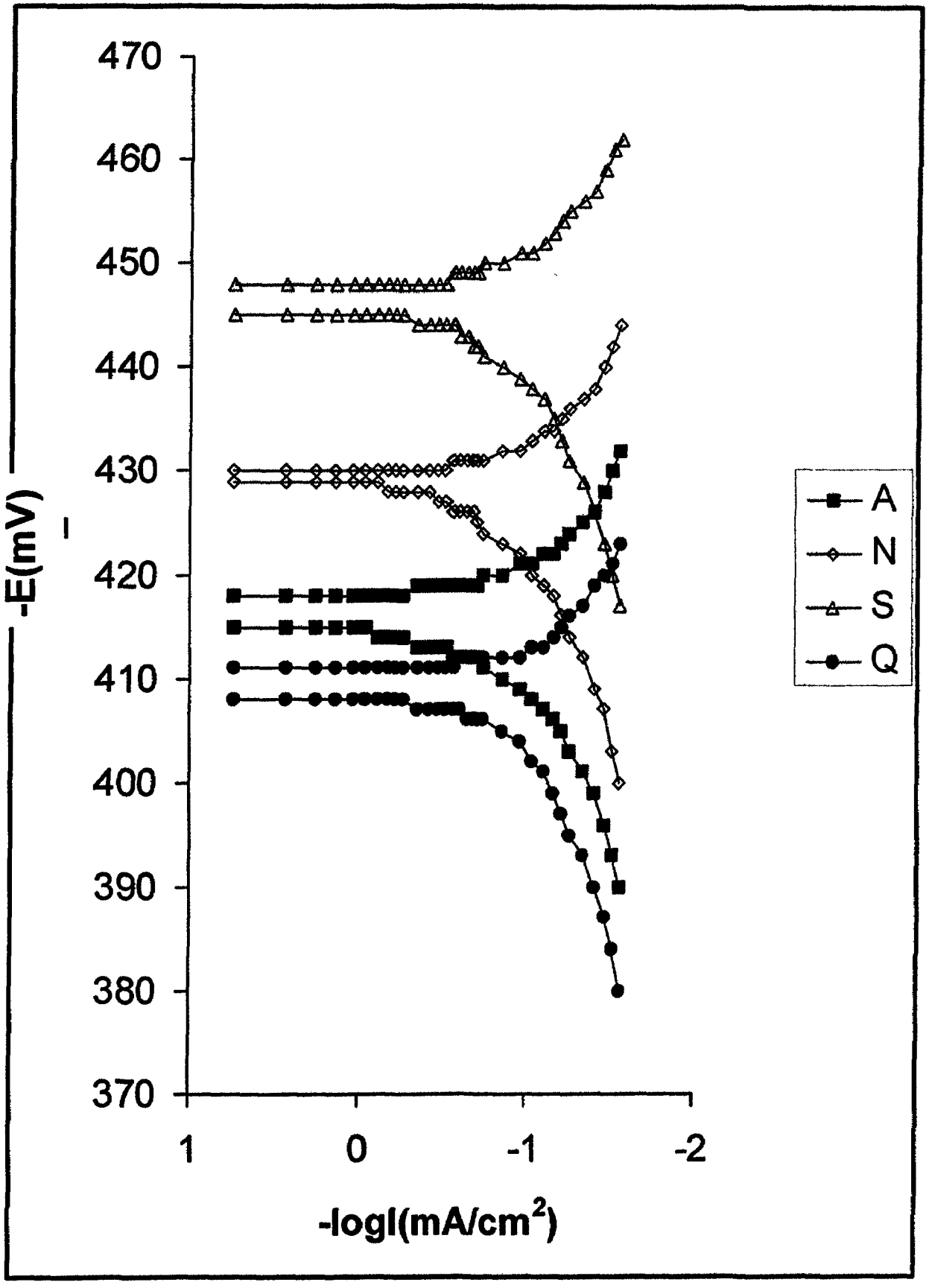
Fig(69):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of$6x10^{-5}$M of HEAA at 45°C



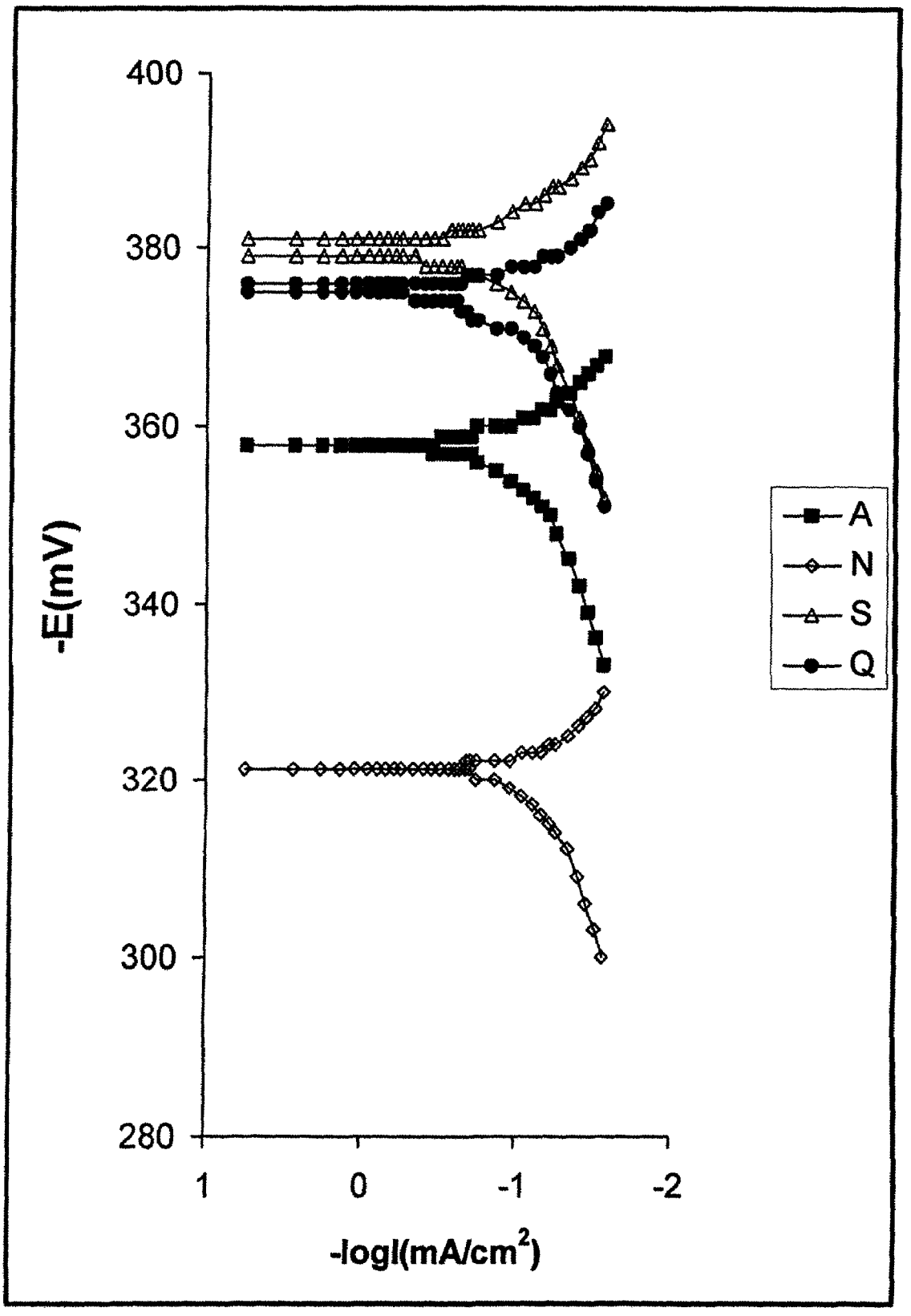
Fig(70):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of$8x10^{-5}$M of HEAA at 45 °C



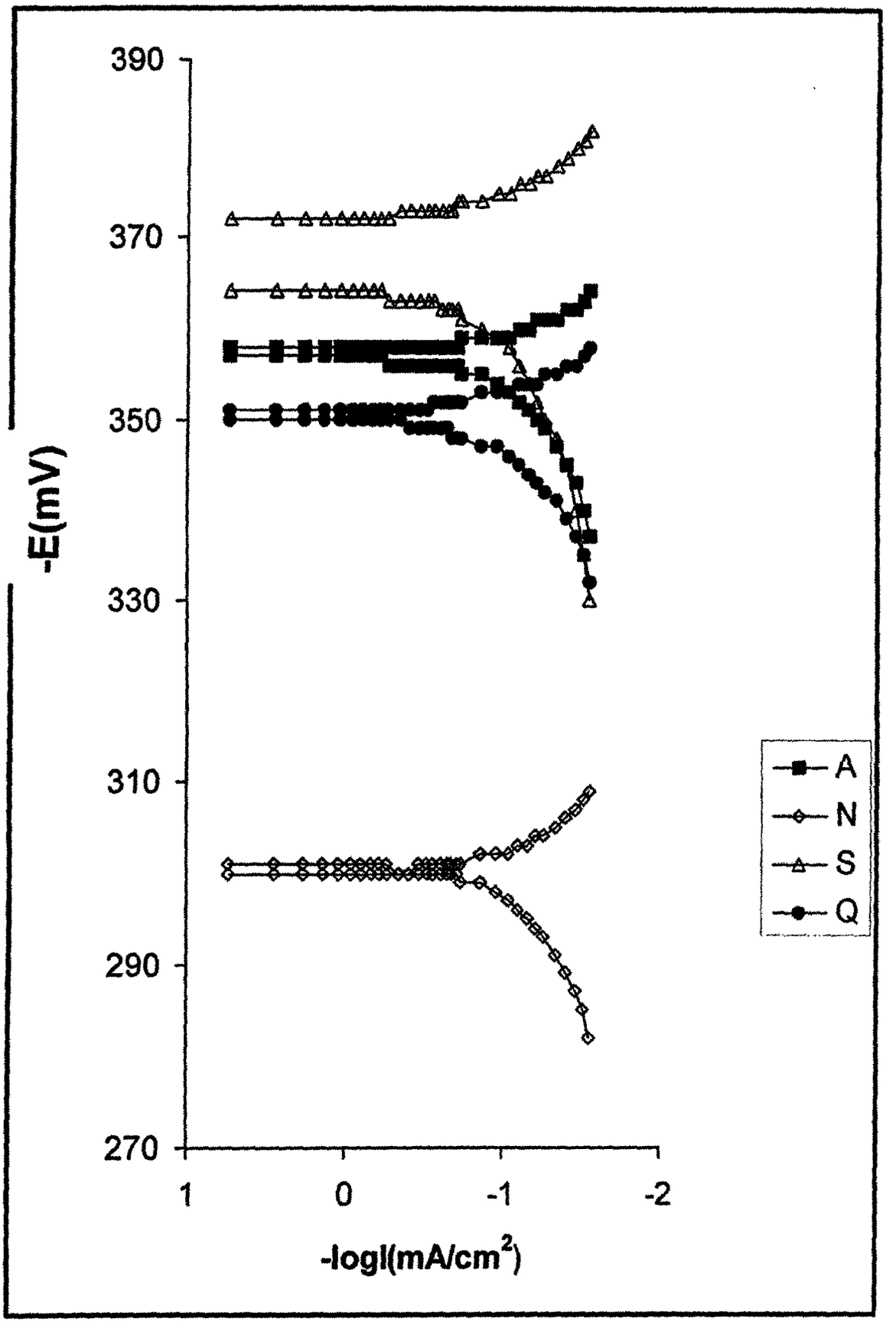
Fig(71):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 10^{-4}M of HEAA at 45 °C



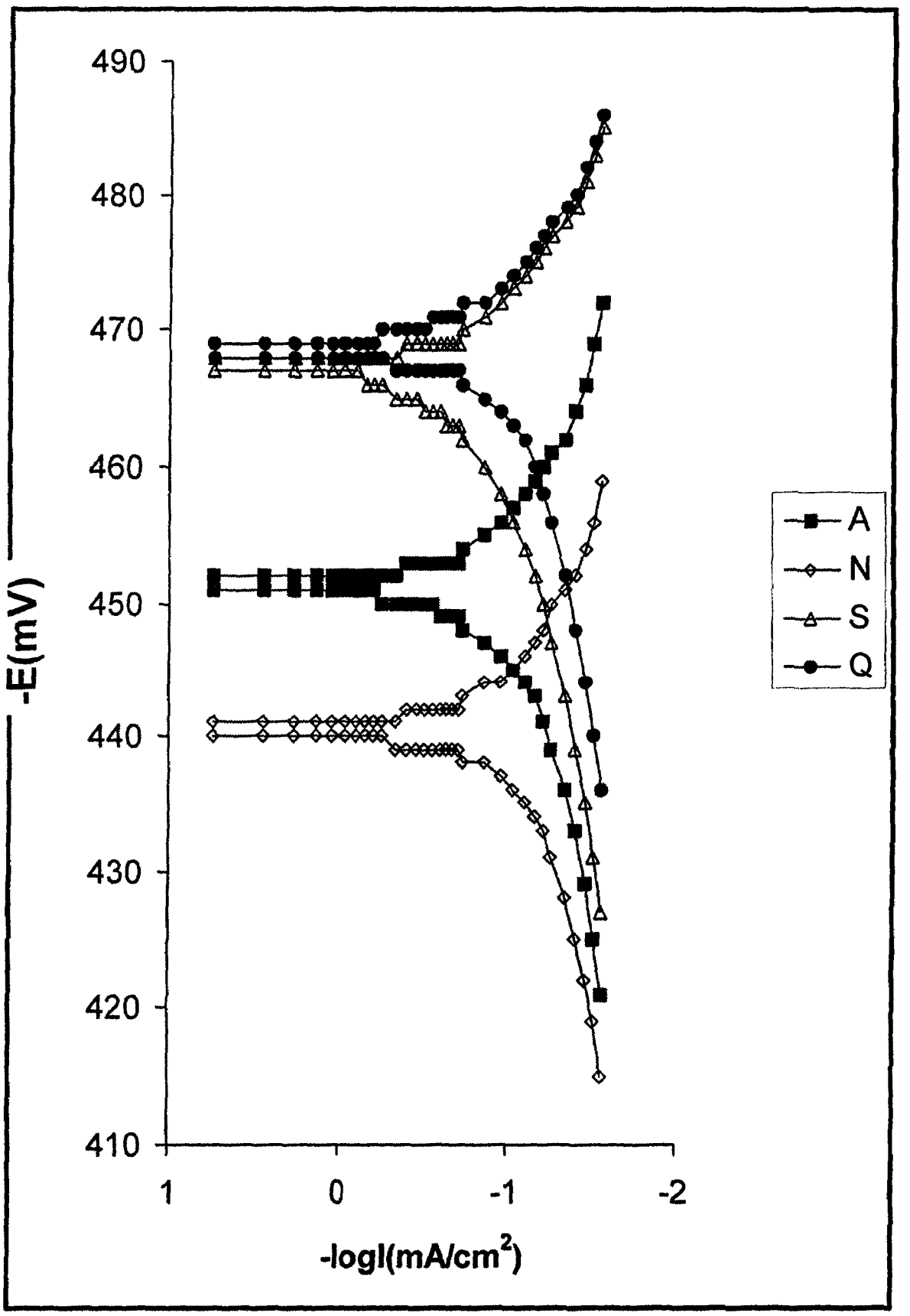
Fig(72):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 at 55°C



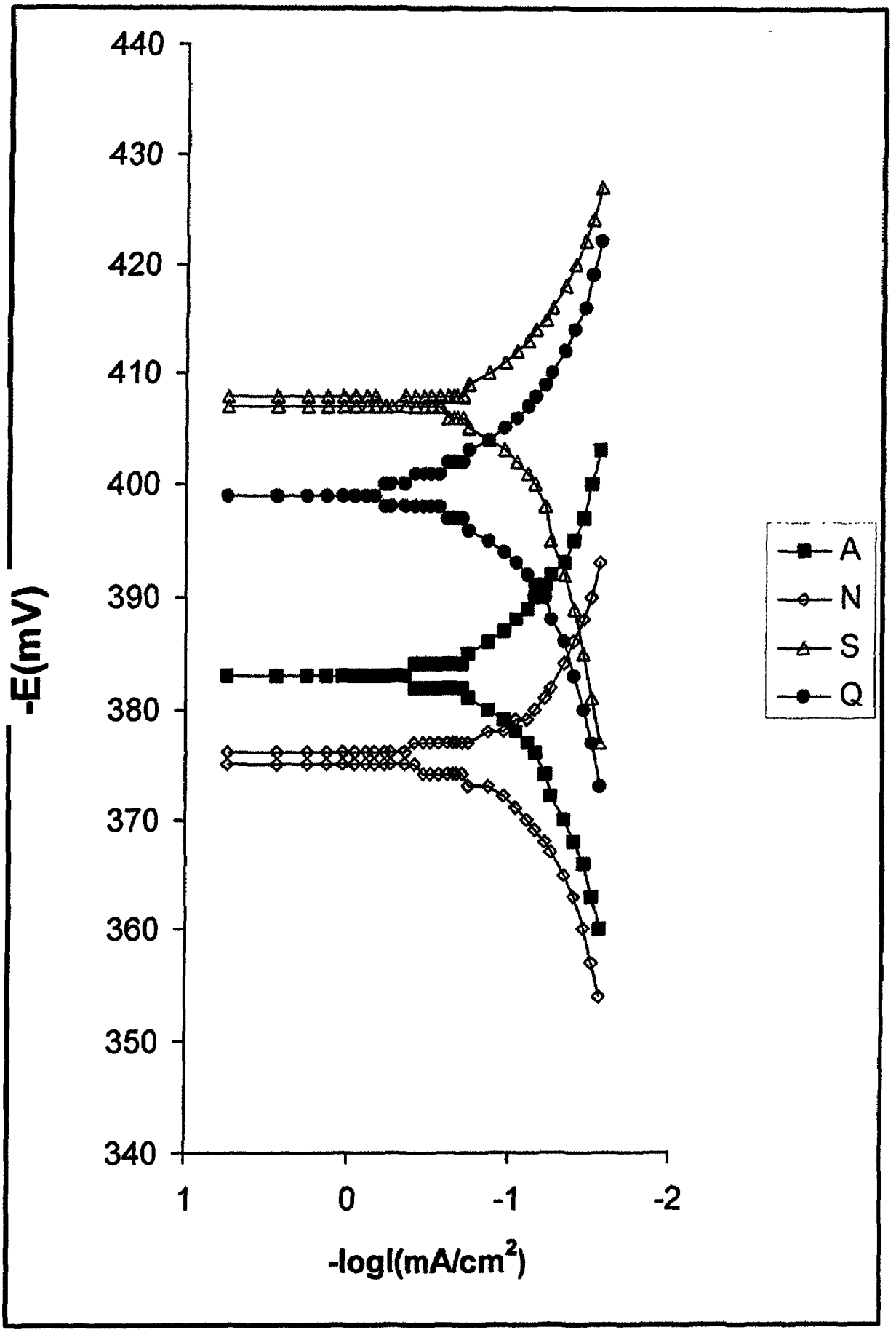
Fig(73):Tafle lines for M.C.V. steel samples in 0.3 M HNO_3 at 55°C



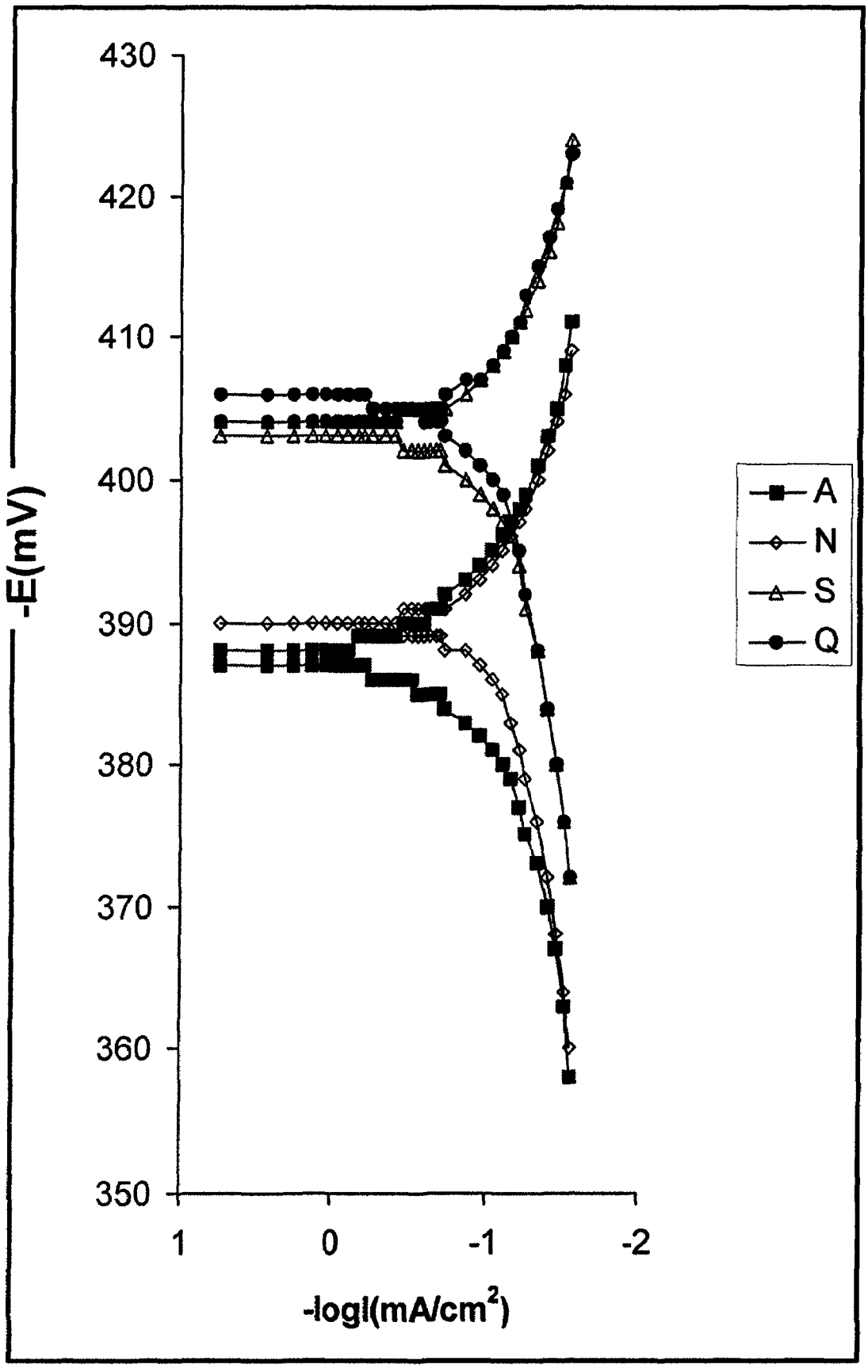
Fig(74):Tafle lines for M.C.V. steel samples in 0.5 M HNO_3 at 55°C



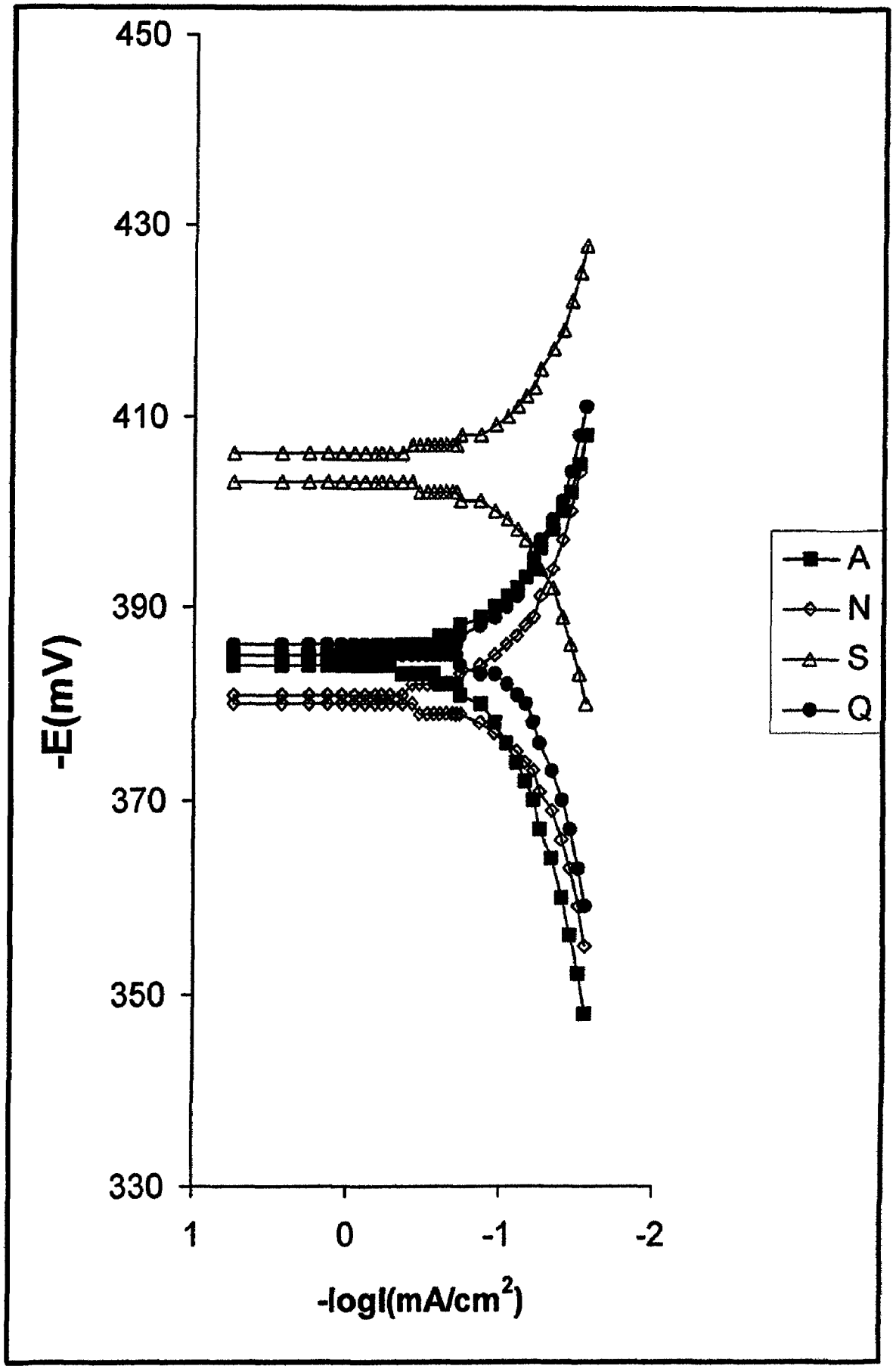
Fig(75):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 2 x10^{-5}M of HEAA at 55 °C



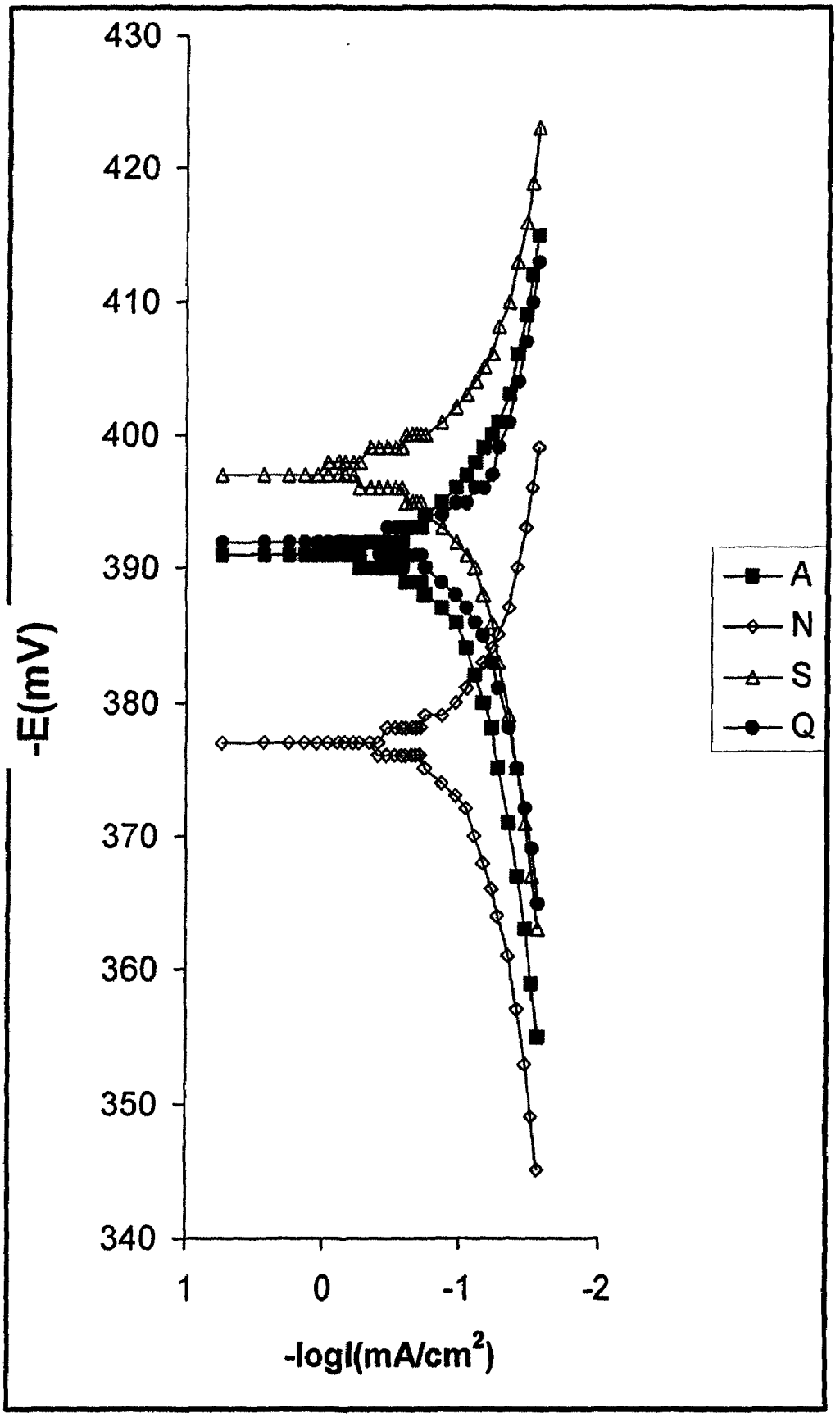
Fig(76):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 4×10^{-5}M of HEAA at 55 °C



Fig(77):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 6 x10^{-5}M of HEAA at 55 °C



Fig(78):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 8 x10^{-5}M of HEAA at 55 °C



Fig(79):Tafle lines for M.C.V. steel samples in 0.1M HNO_3 and in presence of 10^{-4}M of HEAA at 55 °C

B) Calculations of corrosion resistance[6-13]

From Tafel lines for all samples under study, the corresponding E_{corr} can be determined.

Therefore, E_s can be determined from the following equation[6-13]:

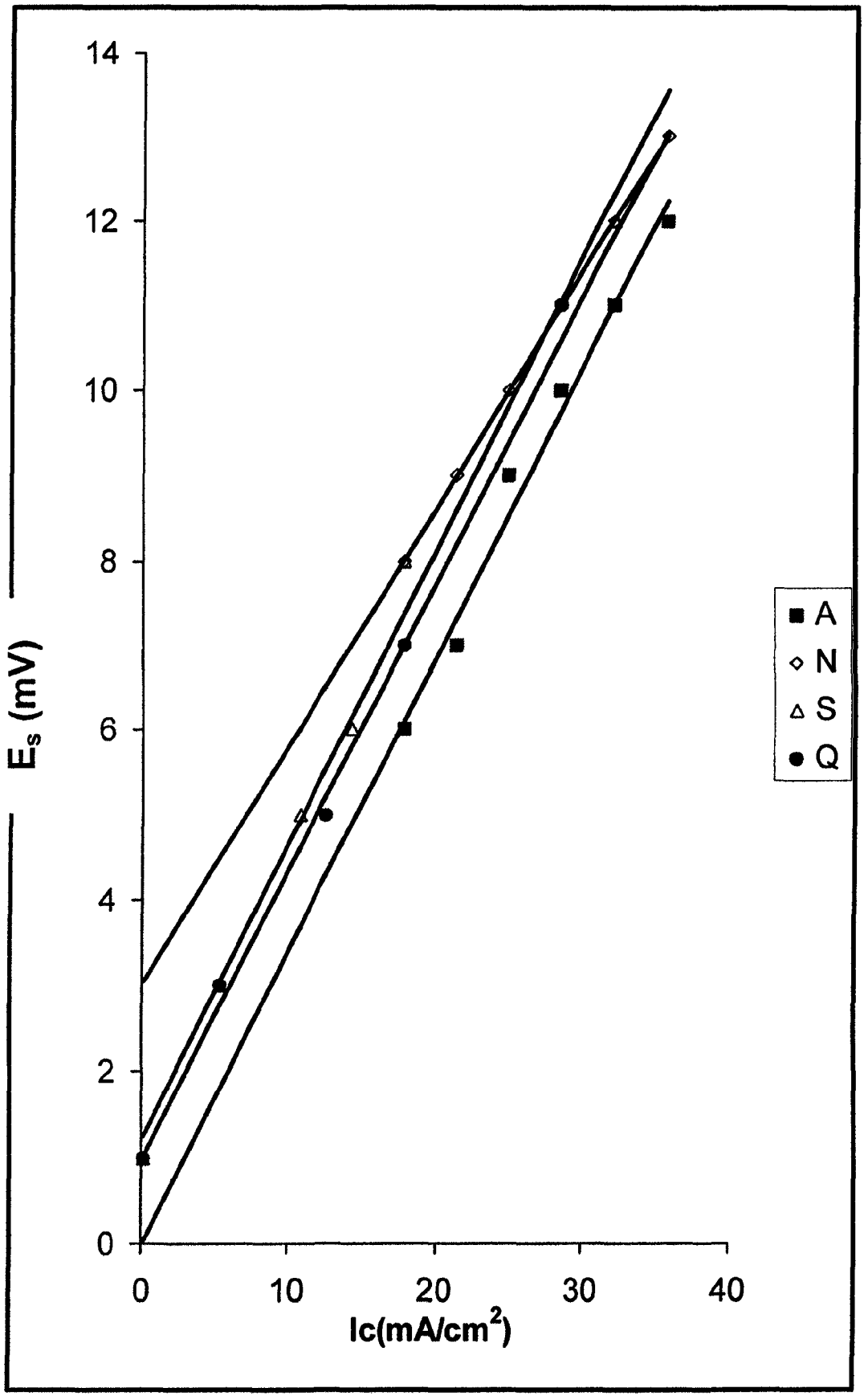
$$E_s = E - E_{corr} \quad (20)$$

Where E is the measured potential.

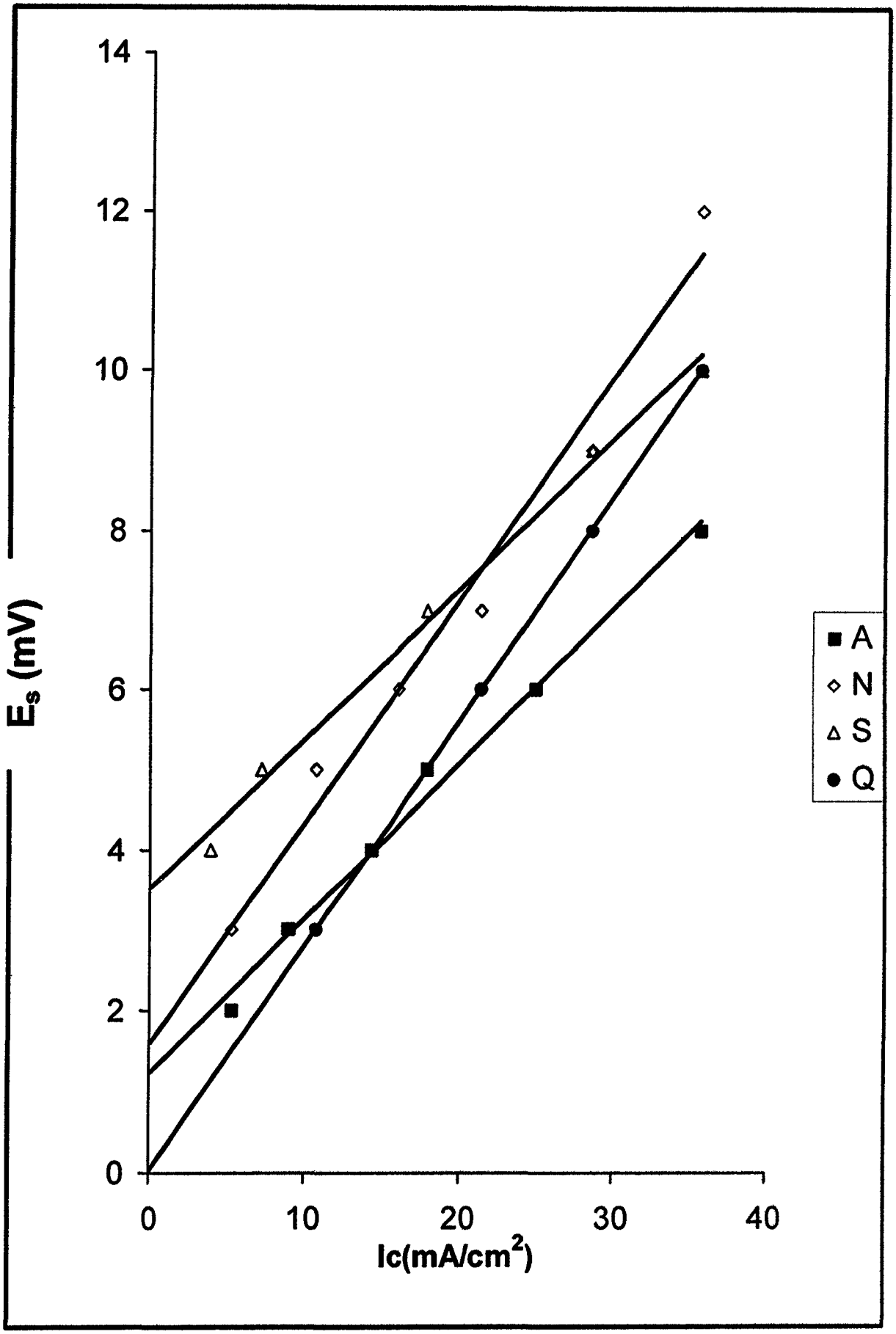
Then, plotting E_s against I_c (cathodic current density), which in straight line relationship, with slop equal corrosion resistance.

Figures(80-111) represent plotting E_s vs. I_c for L.C.V.steel samples in (0.1, 0.3, and 0.5 M) HNO_3 acid and 0.1 M HNO_3 in different concentrations of HEAA ($2x10^{-5}$, $4x10^{-5}$, $6x10^{-5}$, $8 x10^{-5}$ and 10^{-4}M) at 25, 35, 45 and 55°C respectively.

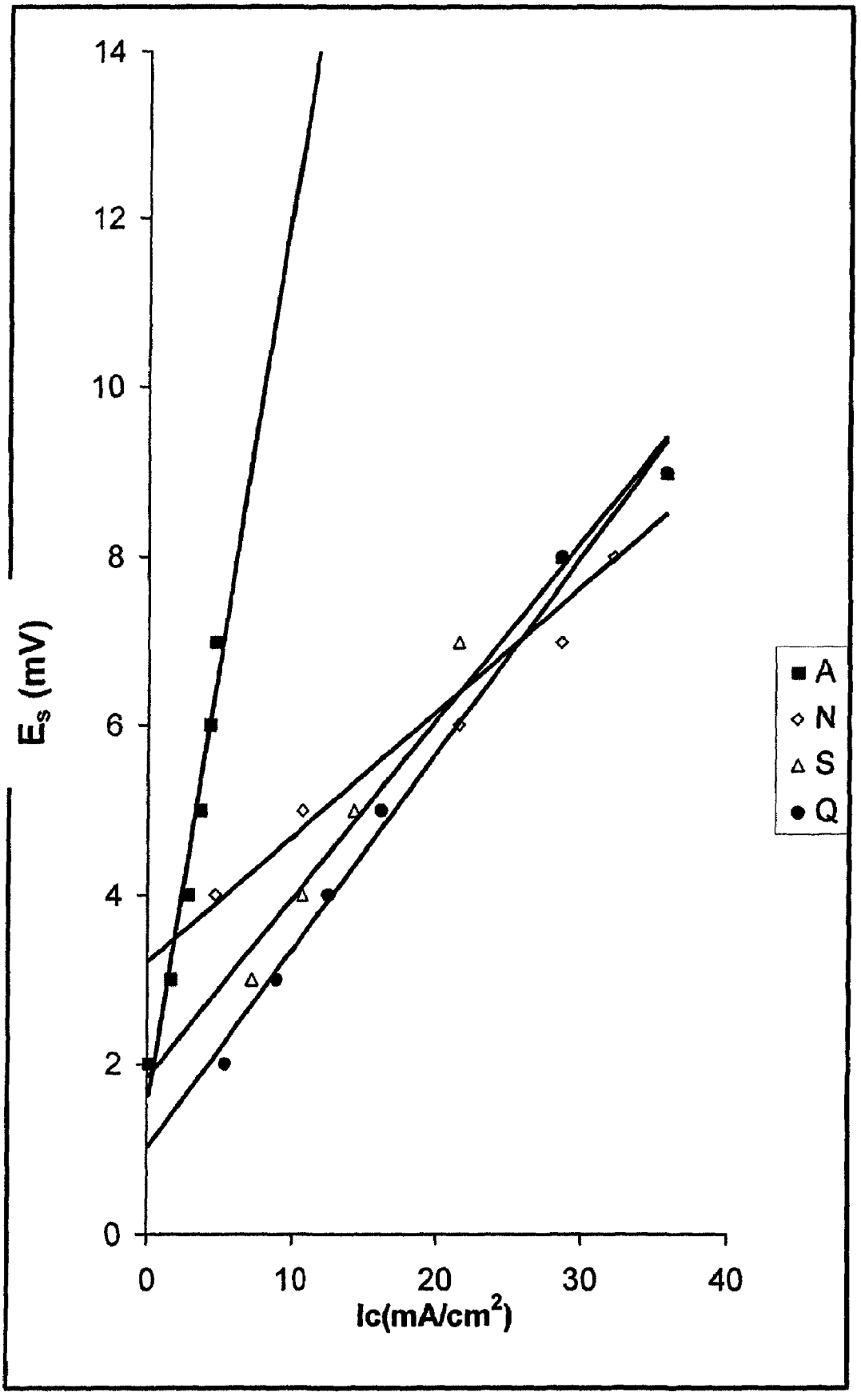
Figures(112-143) represent plotting E_s vs. I_c for M.C.V.steel samples in (0.1,0.3, and 0.5 M) HNO_3 acid and 0.1 M HNO_3 in different concentrations of HEAA ($2x10^{-5}$, $4x10^{-5}$, $6x10^{-5}$, $8 x10^{-5}$ and 10^{-4}M) at 25, 35, 45 and 55°C respectively.



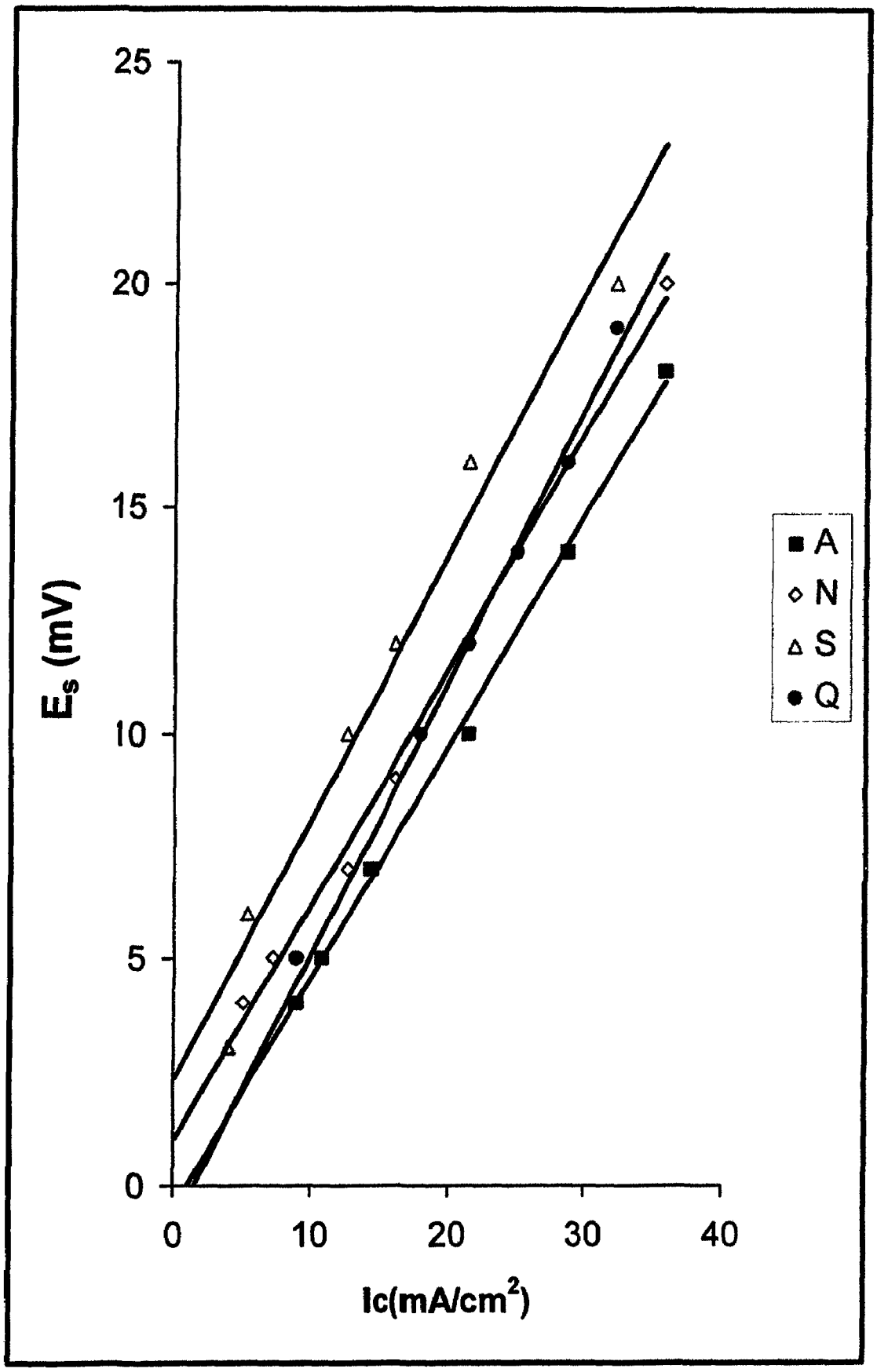
Fig(80): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 25 °C



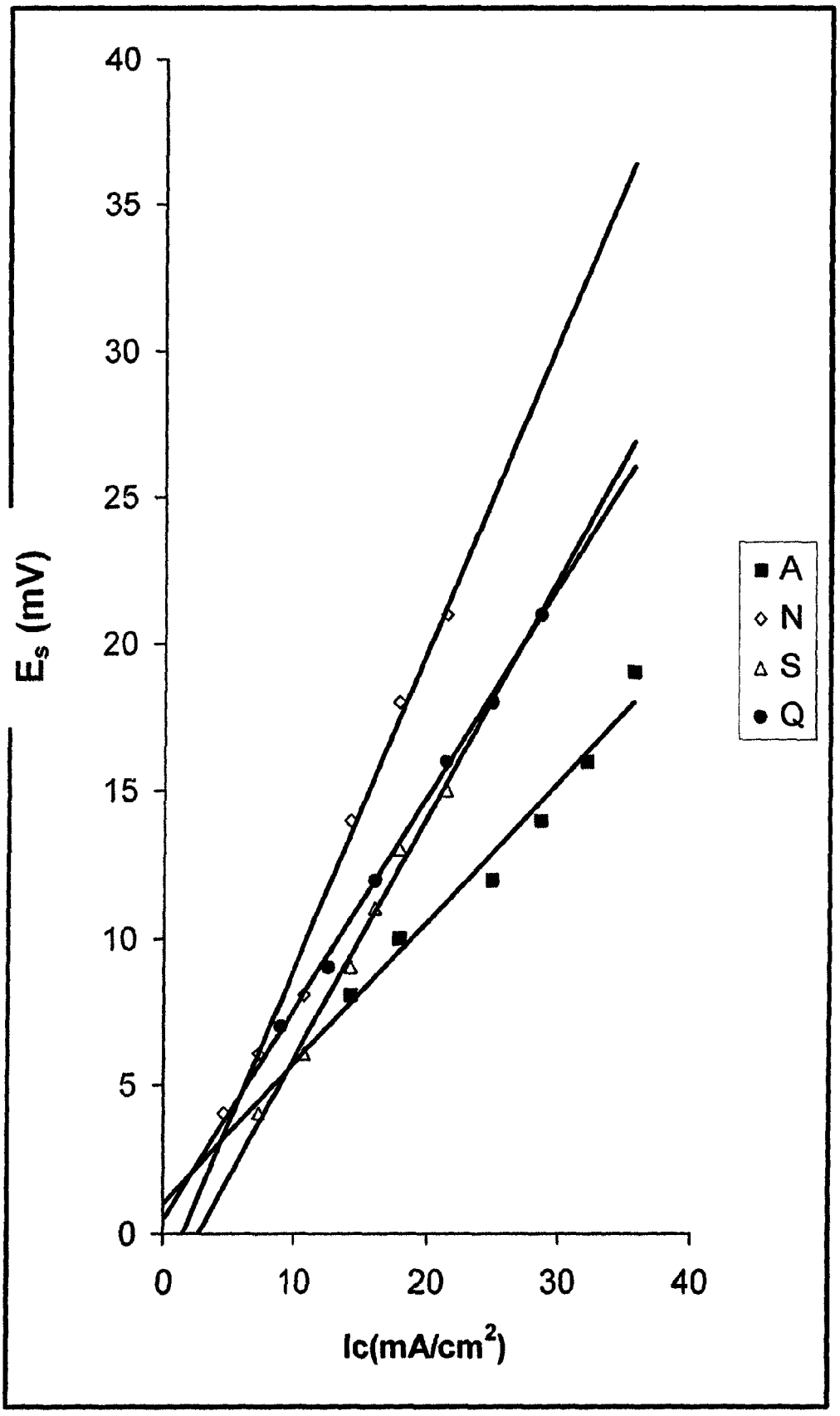
Fig(81): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.3M HNO_3 at 25 °C



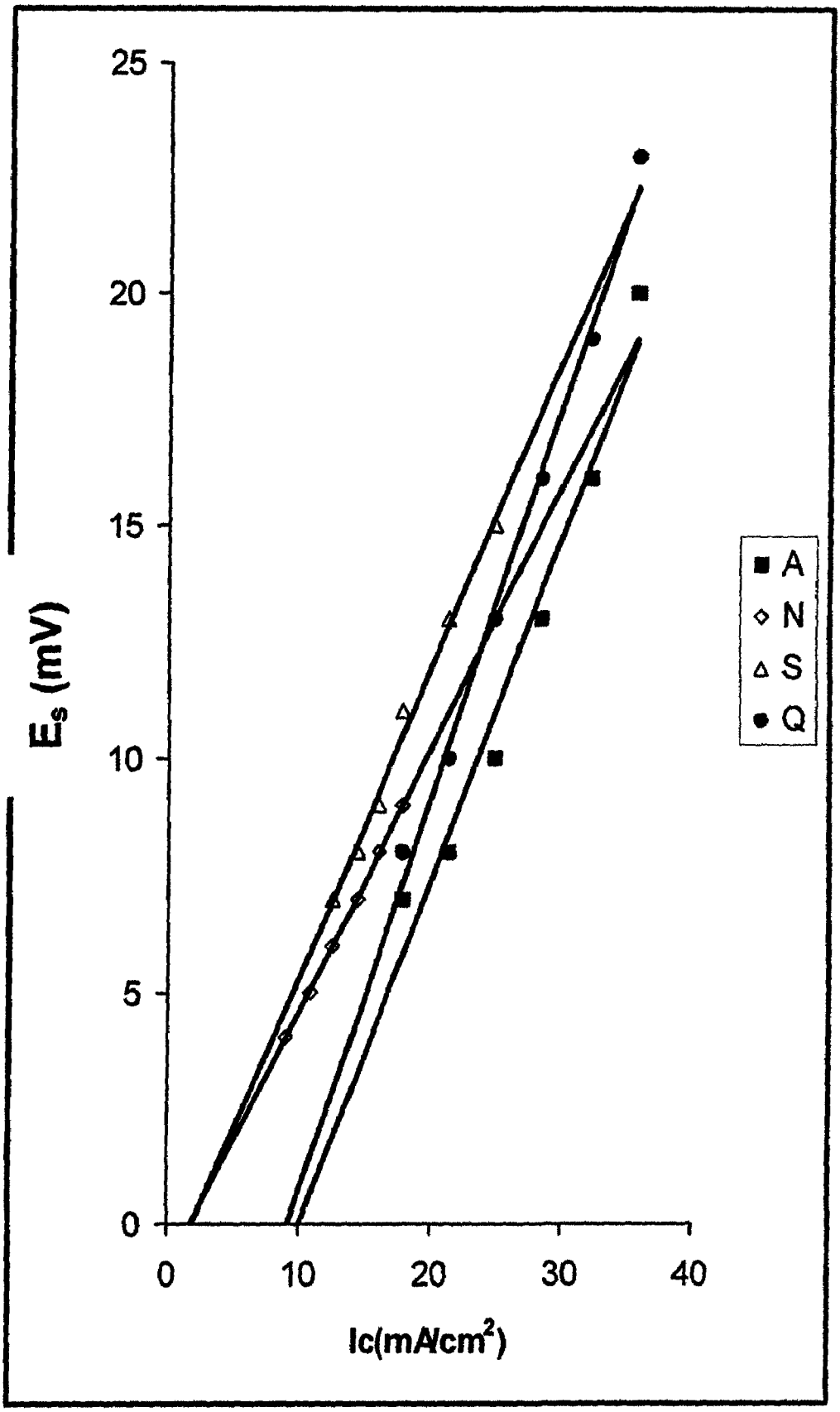
Fig(82): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.5 M HNO_3 at 25 °C



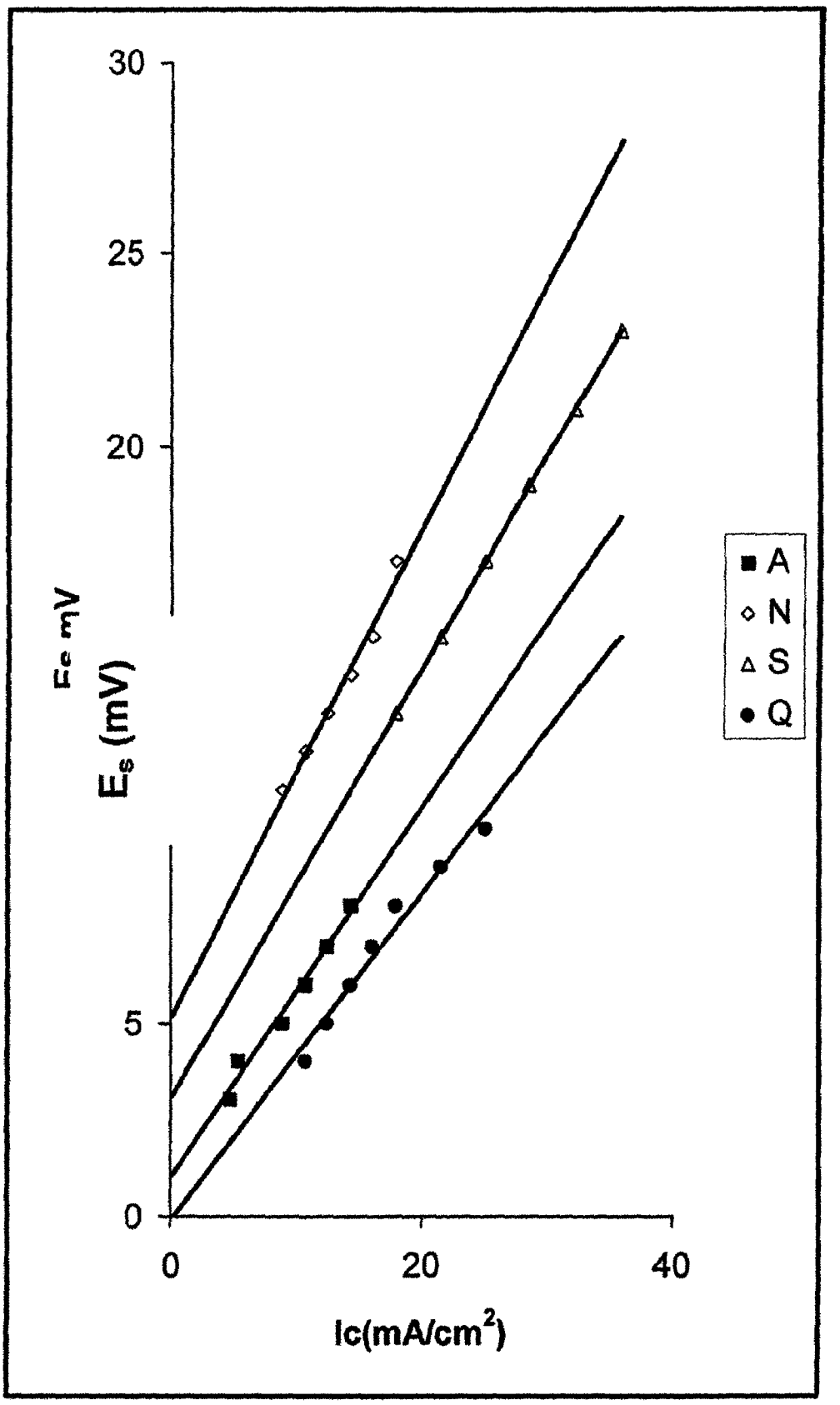
Fig(83): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 2 x10^{-5} M HEAA



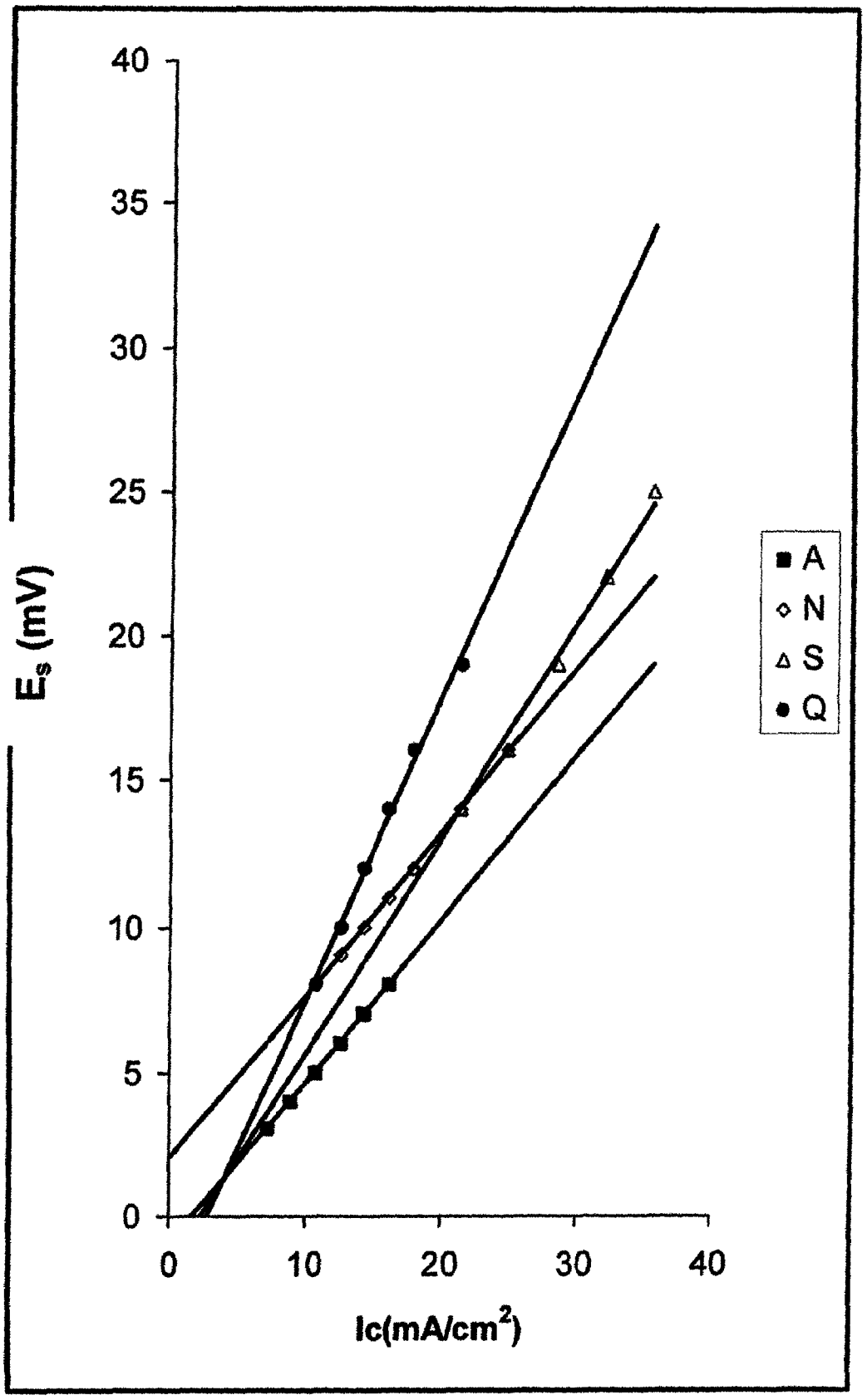
Fig(84): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 4 x10^{-5} M HEAA



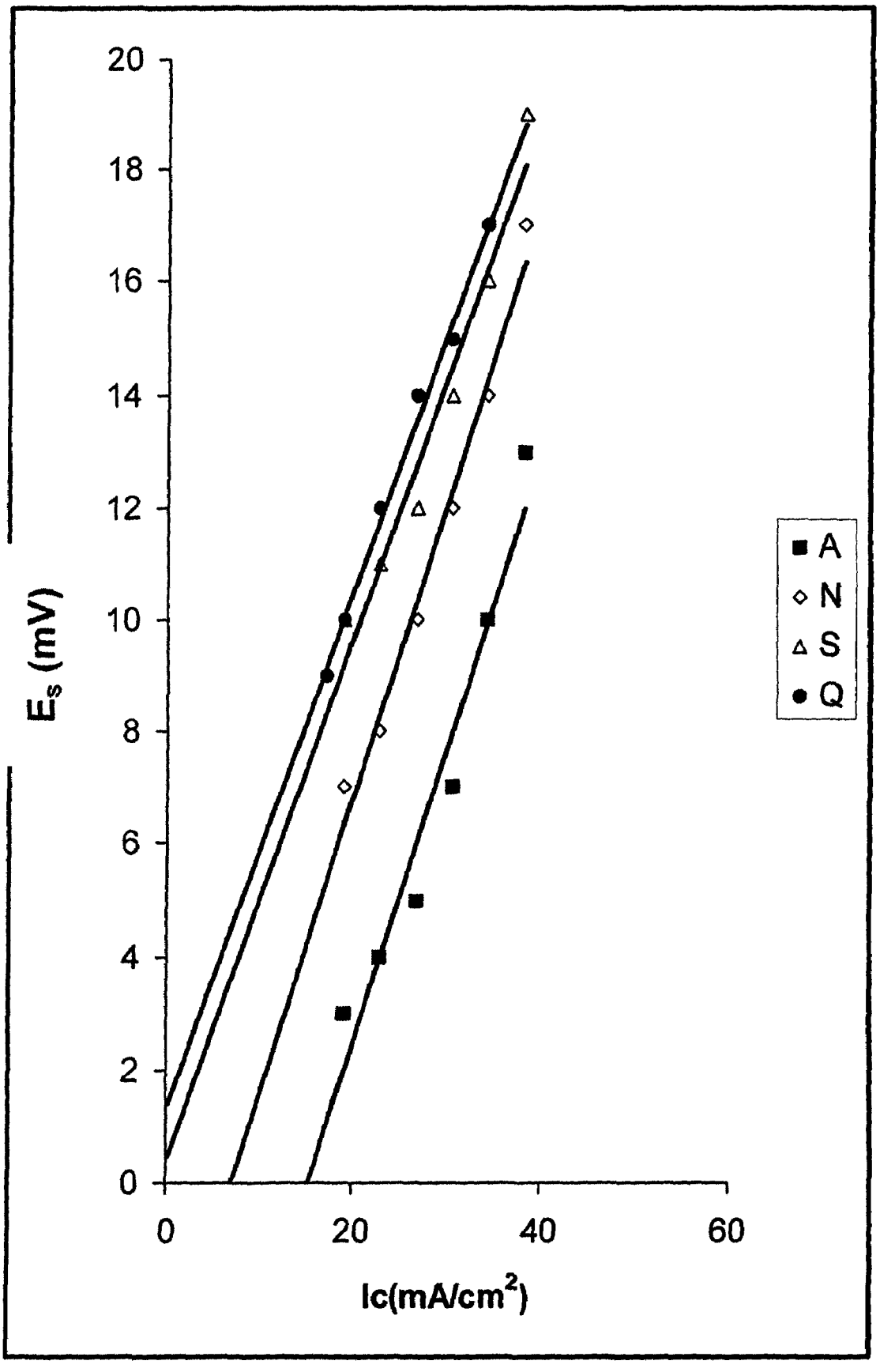
Fig(85): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 6 x10^{-5} M HEAA



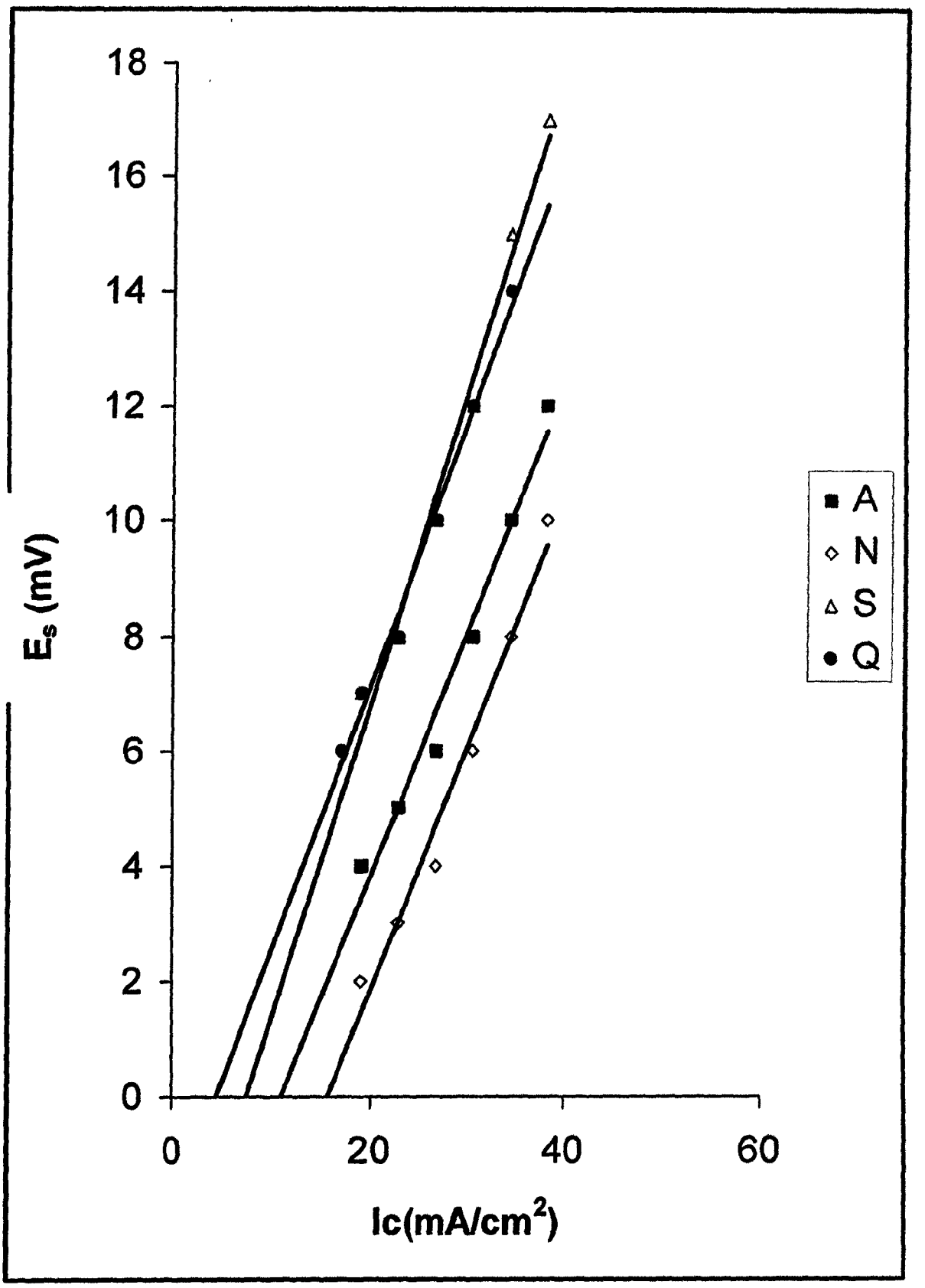
Fig(86): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 8 x10^{-5} M HEAA



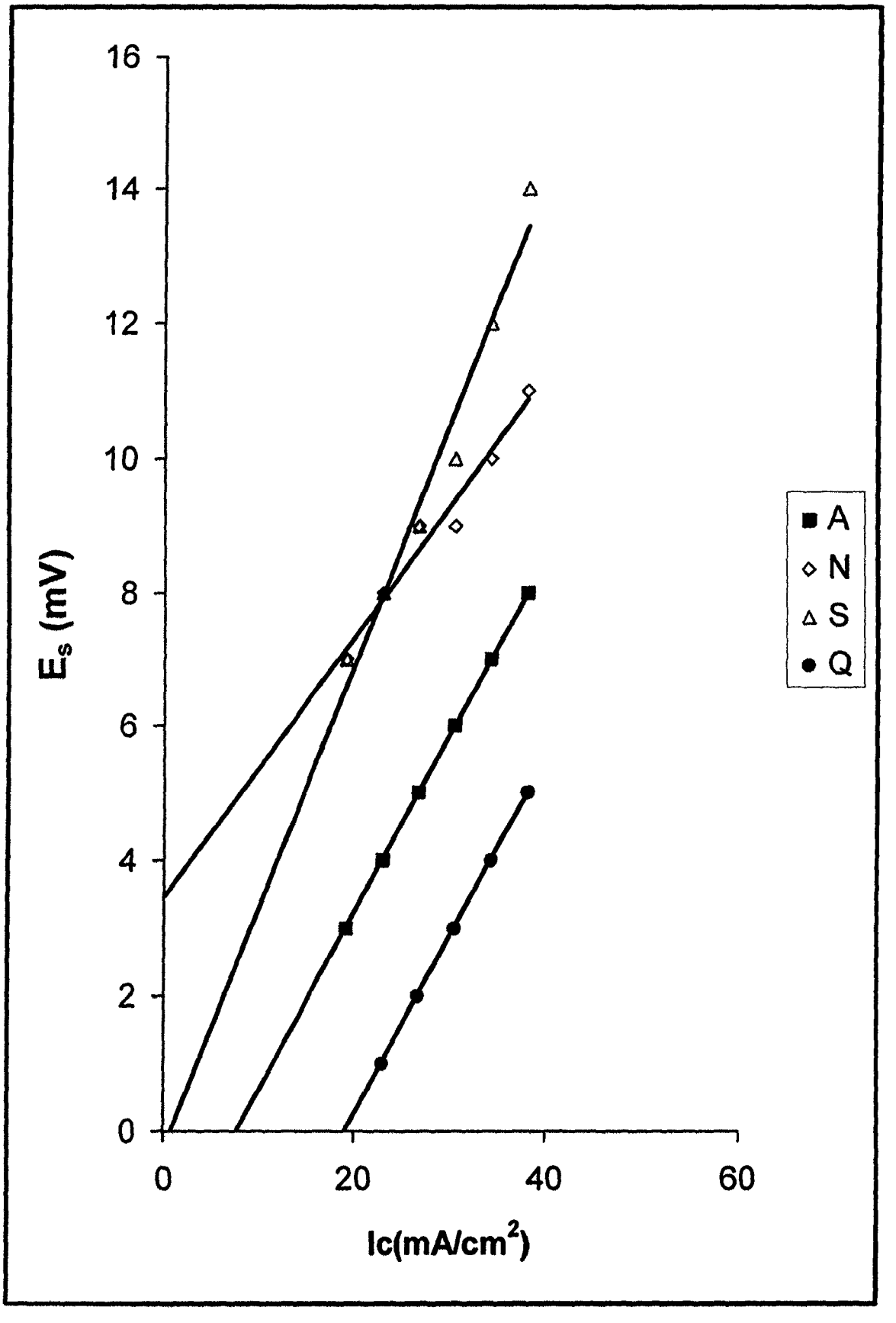
Fig(87): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 10^{-4} M HEAA



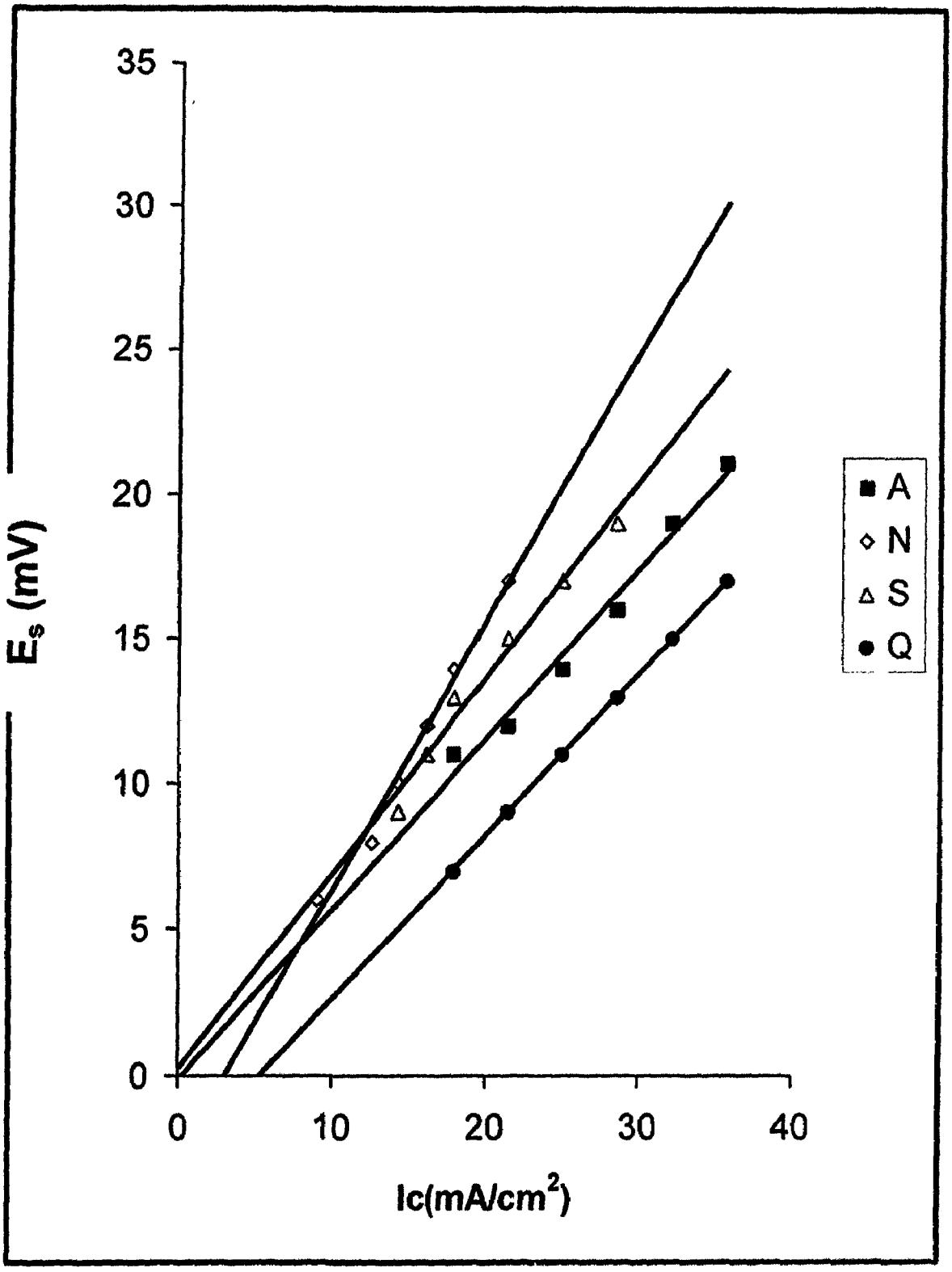
Fig(88): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 35 °C



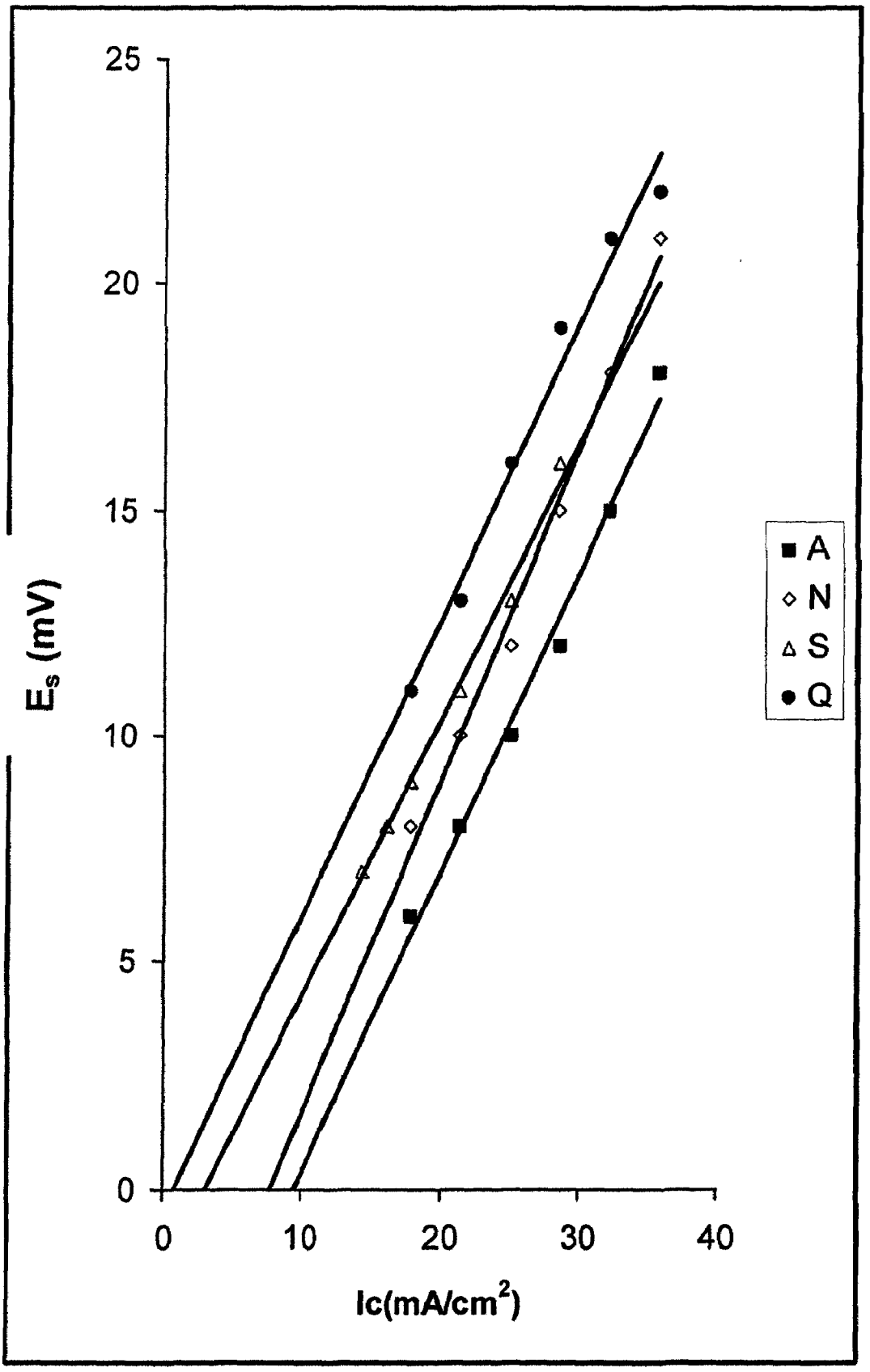
Fig(89): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.3 M HNO_3 at 35 °C



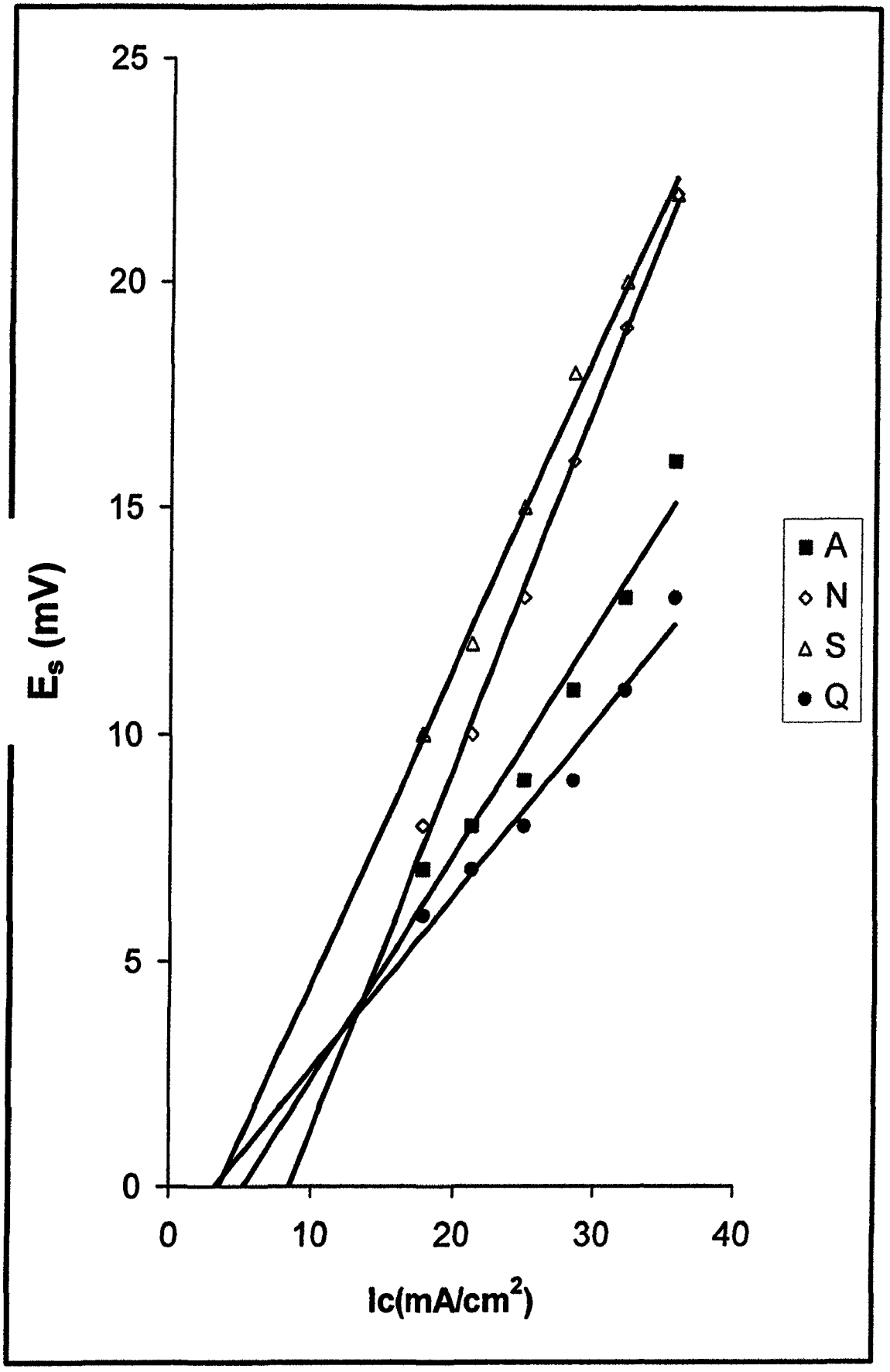
Fig(90): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.5 M HNO_3 at 35 °C



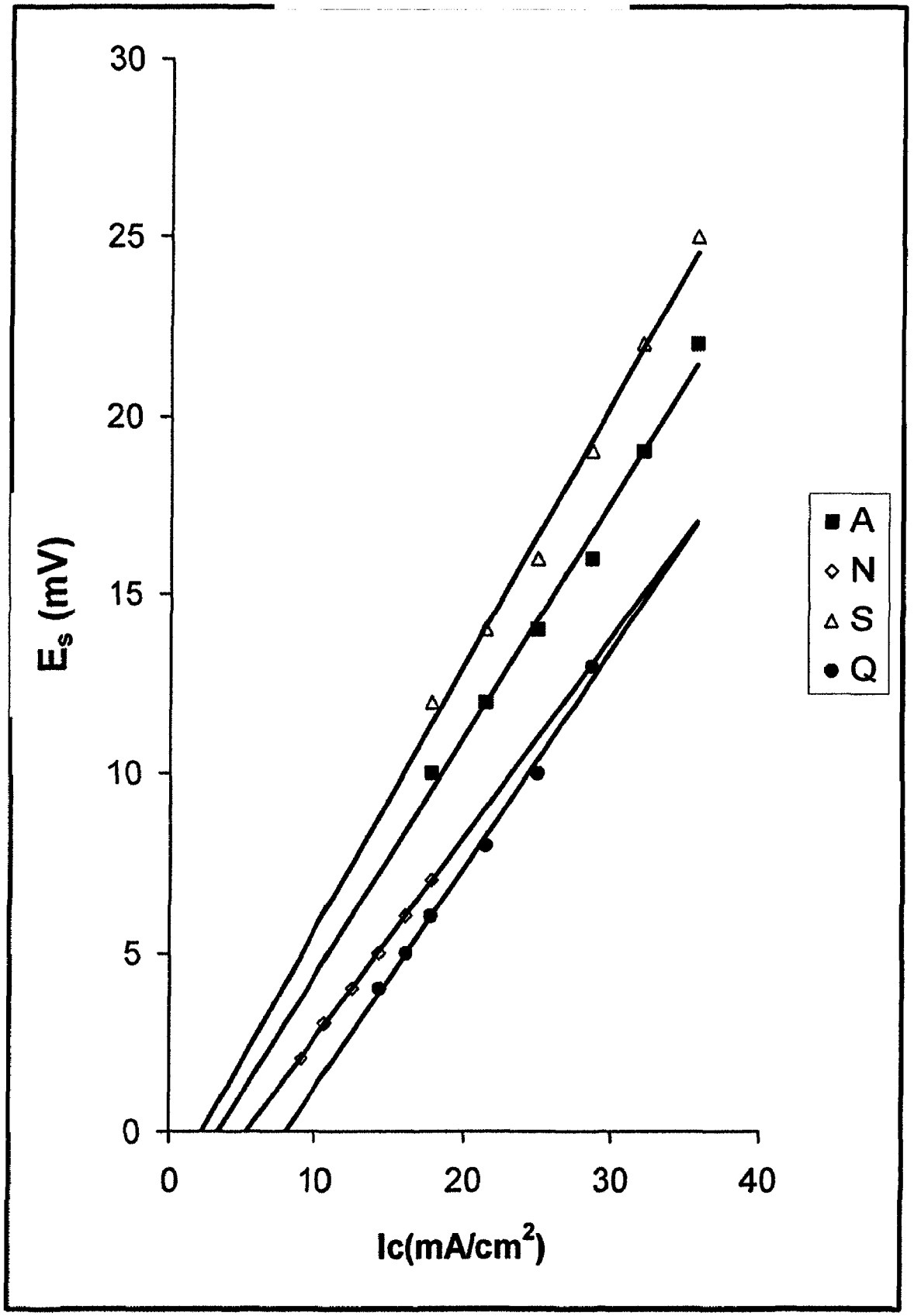
Fig(91): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 35 °C in presence of 2 x10^{-5}M HEAA



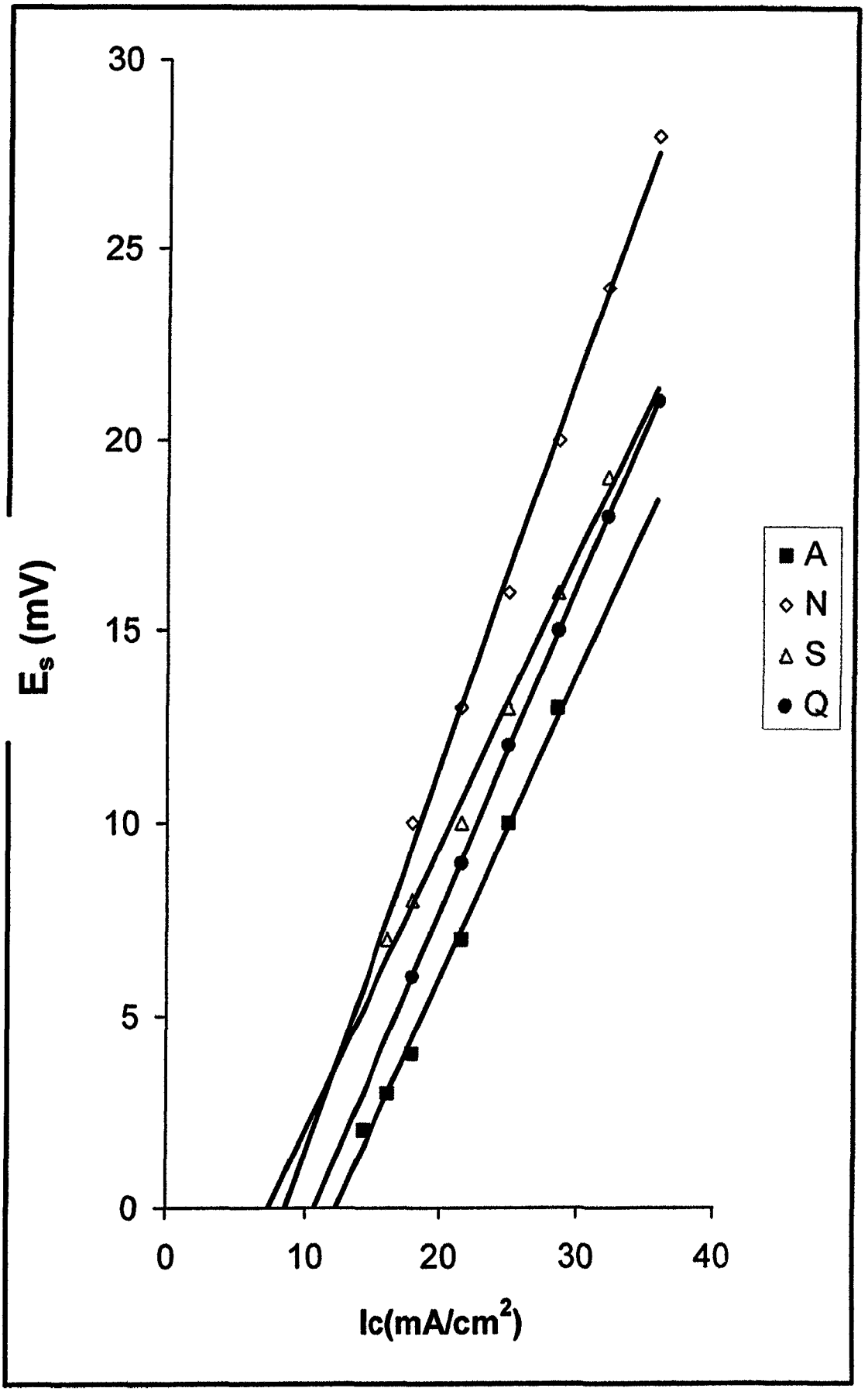
Fig(92): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 35 °C in presence of 4 x10^{-5}M HEAA



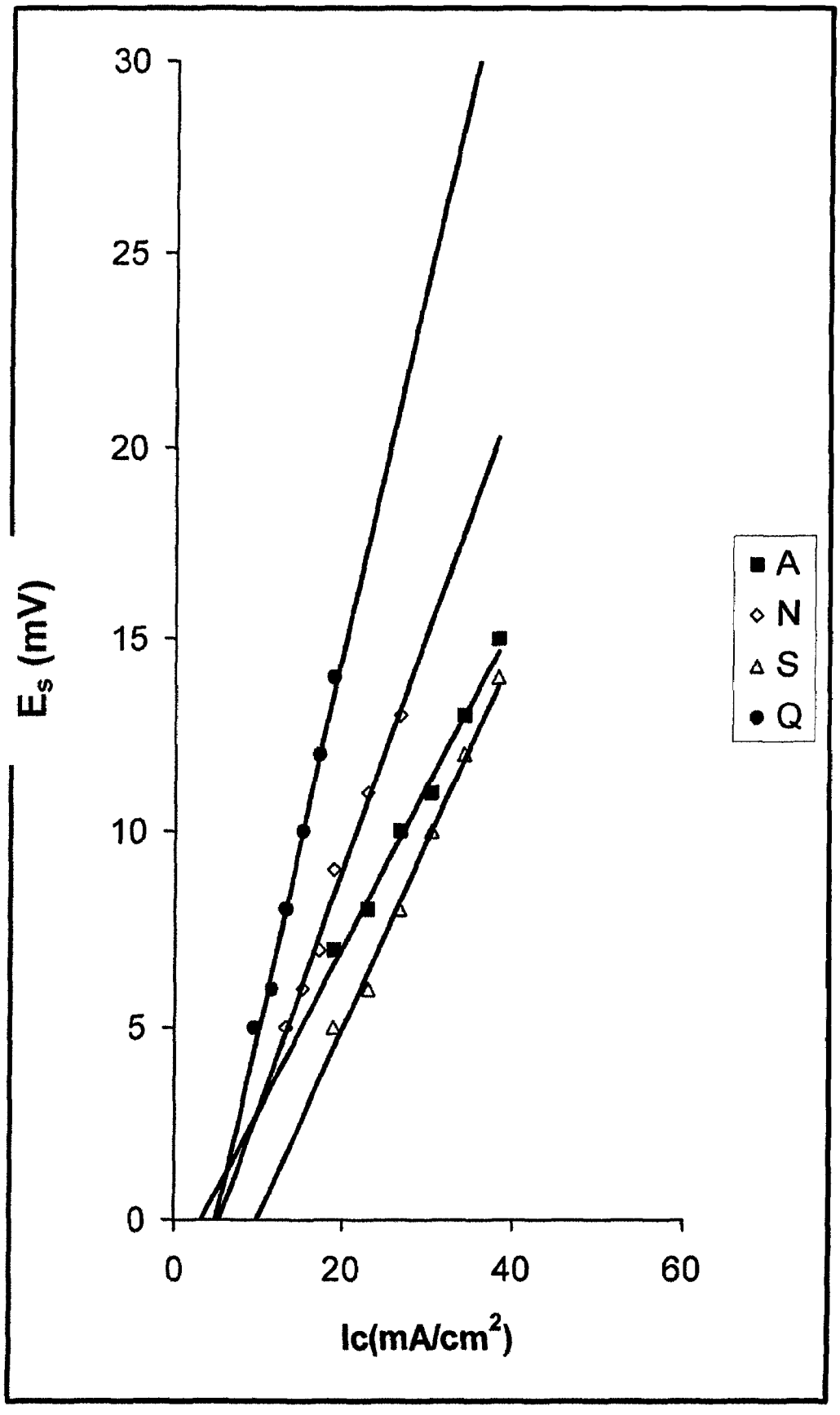
Fig(93): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 35 °C in presence of 6 x10^{-5}M HEAA



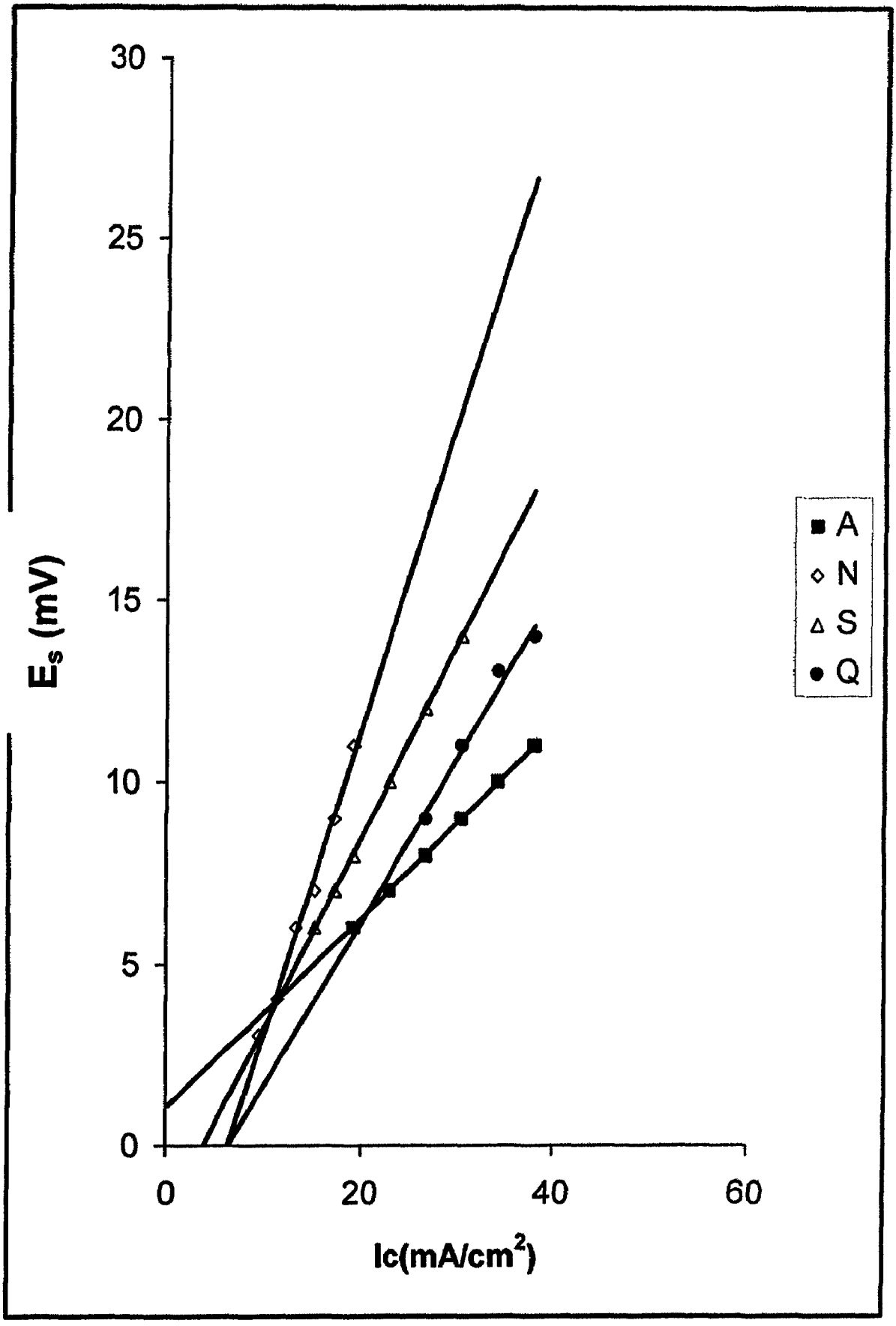
Fig(94): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 35 °C in presence of 8 x10^{-5}M HEAA



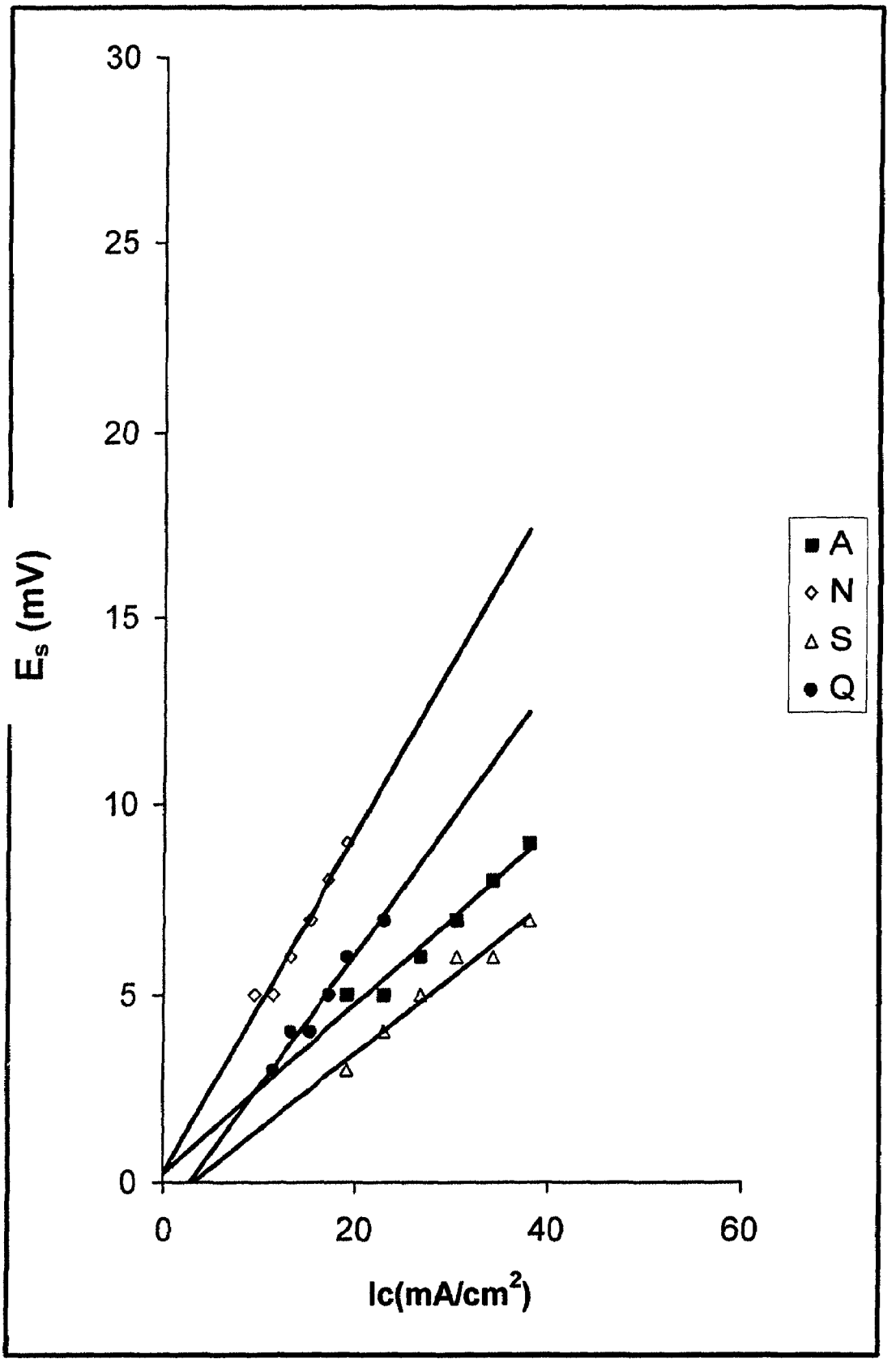
Fig(95): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 35 °C in presence of 10^{-4}M HEAA



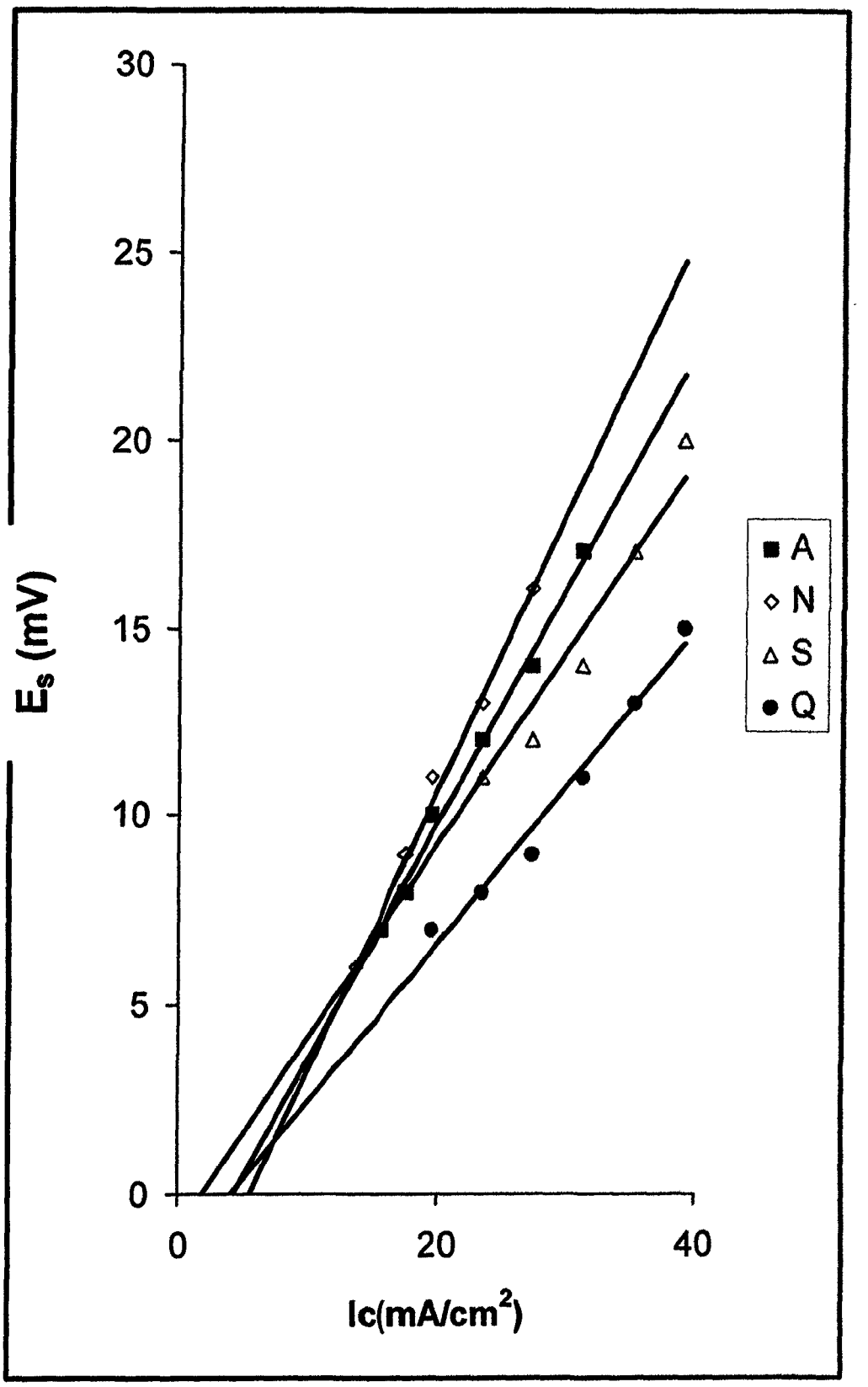
Fig(96): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 45 °C



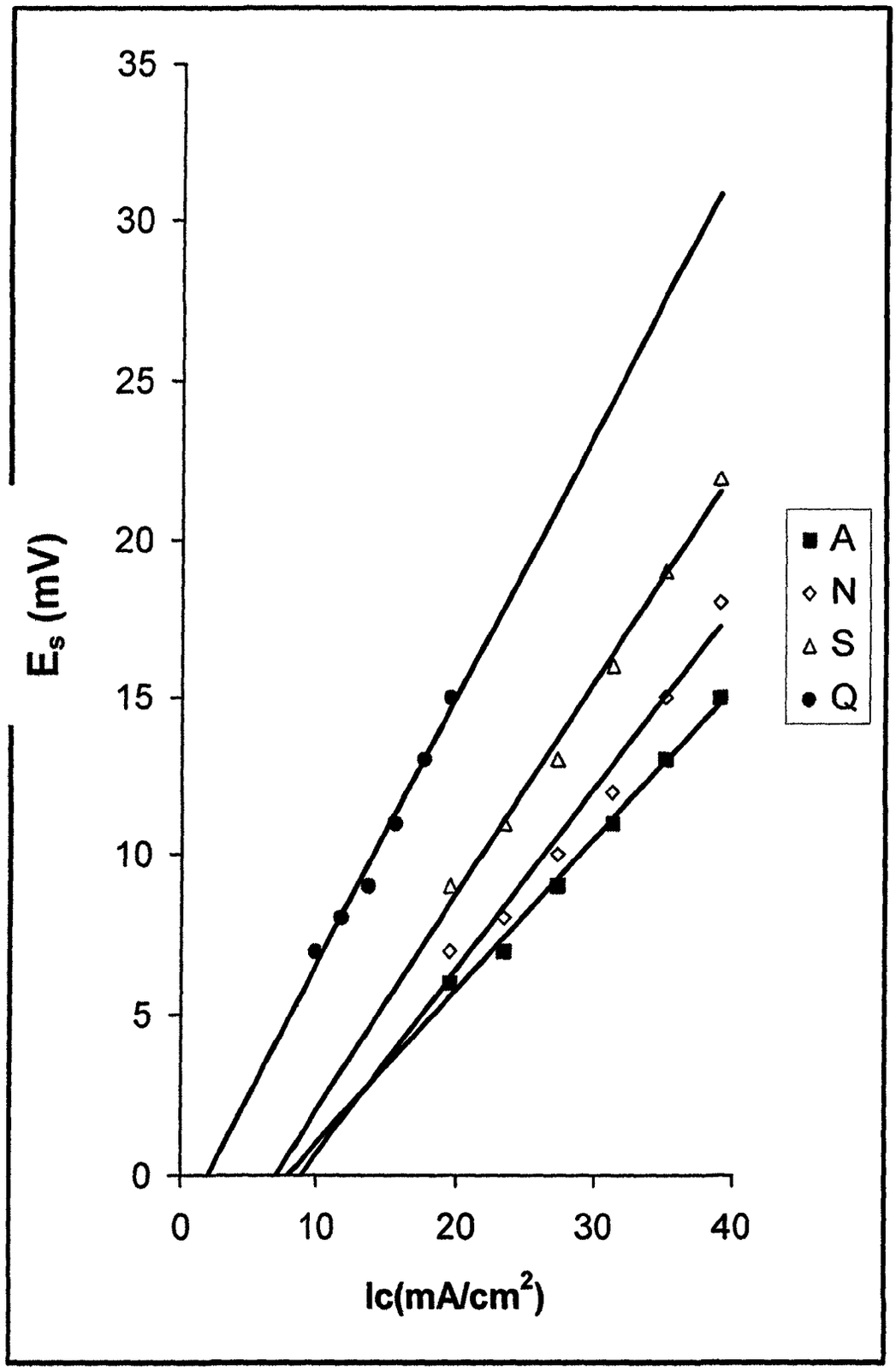
Fig(97): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.3 M HNO_3 at 45 °C



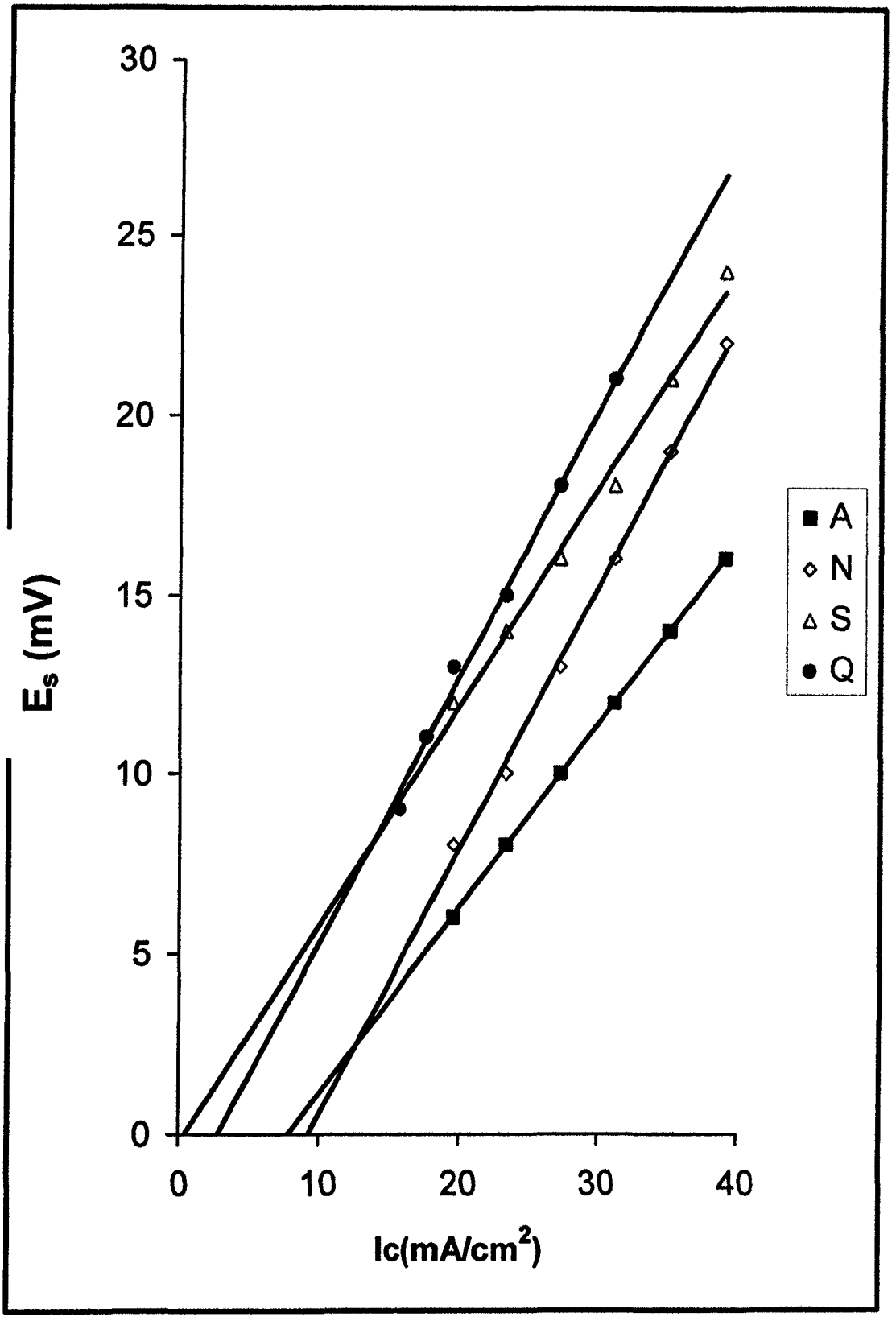
Fig(98): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.5 M HNO_3 at 45 °C



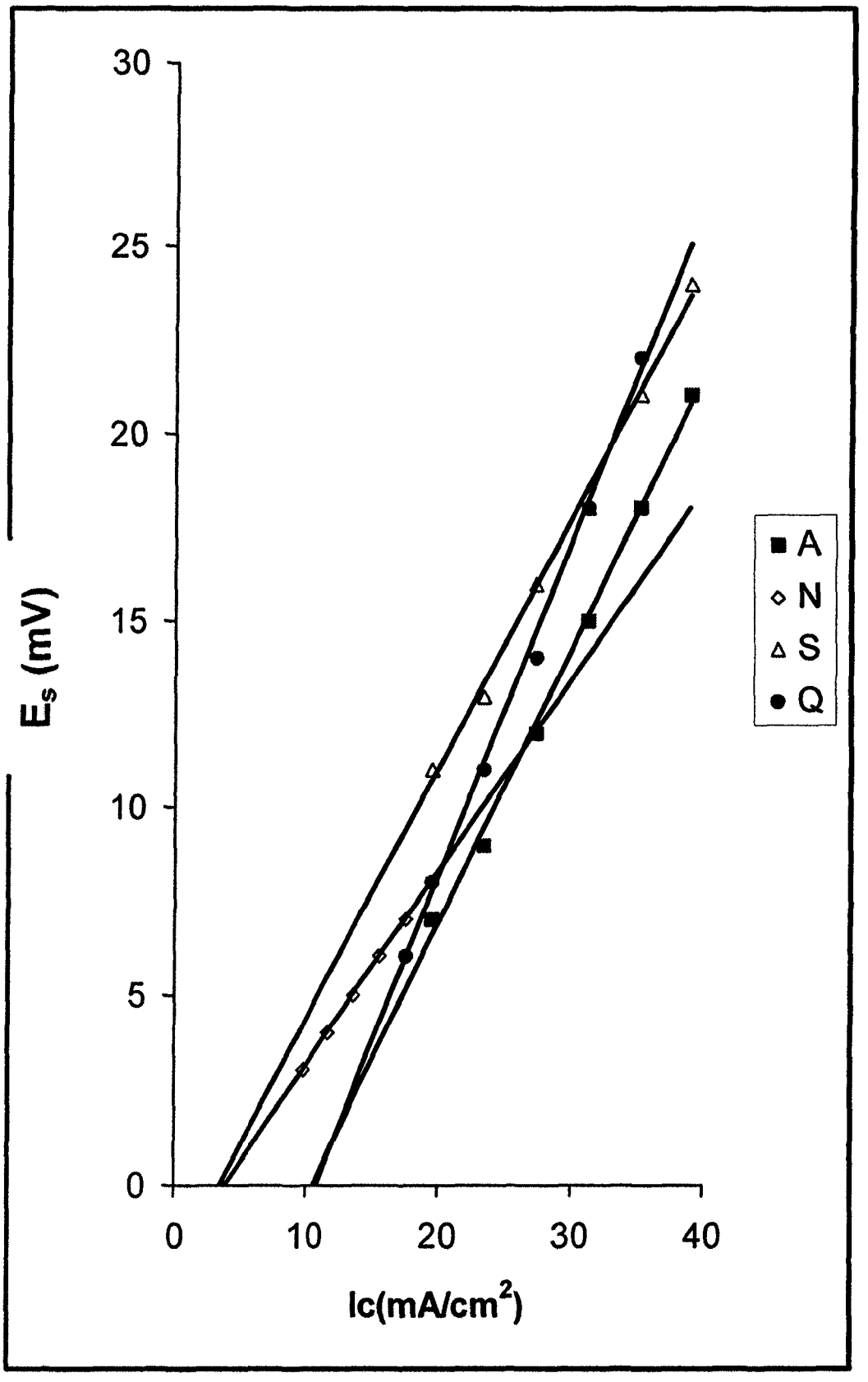
Fig(99): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 2 x10^{-5}M HEAA



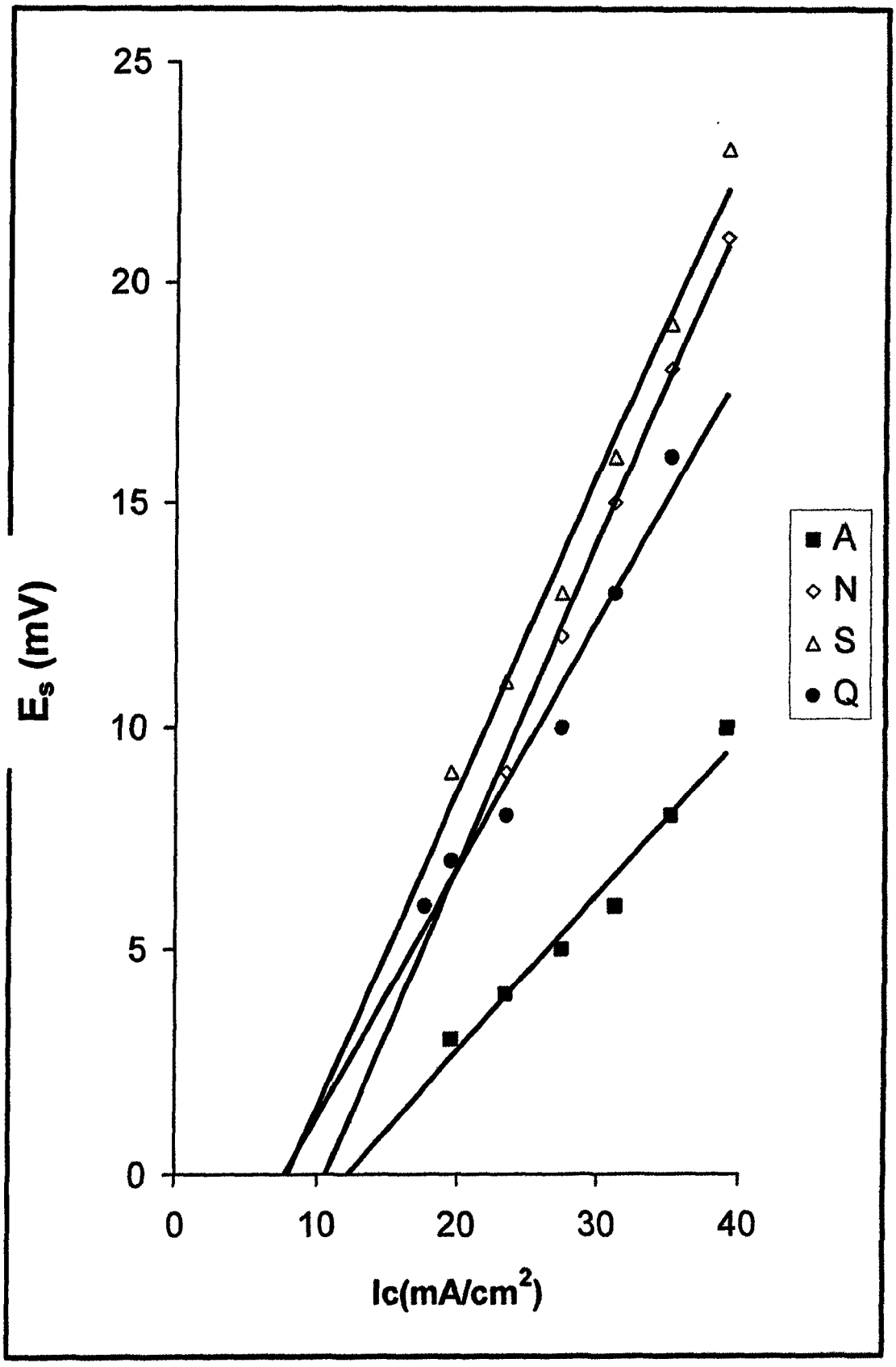
Fig(100): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 4 x10^{-5}M HEAA



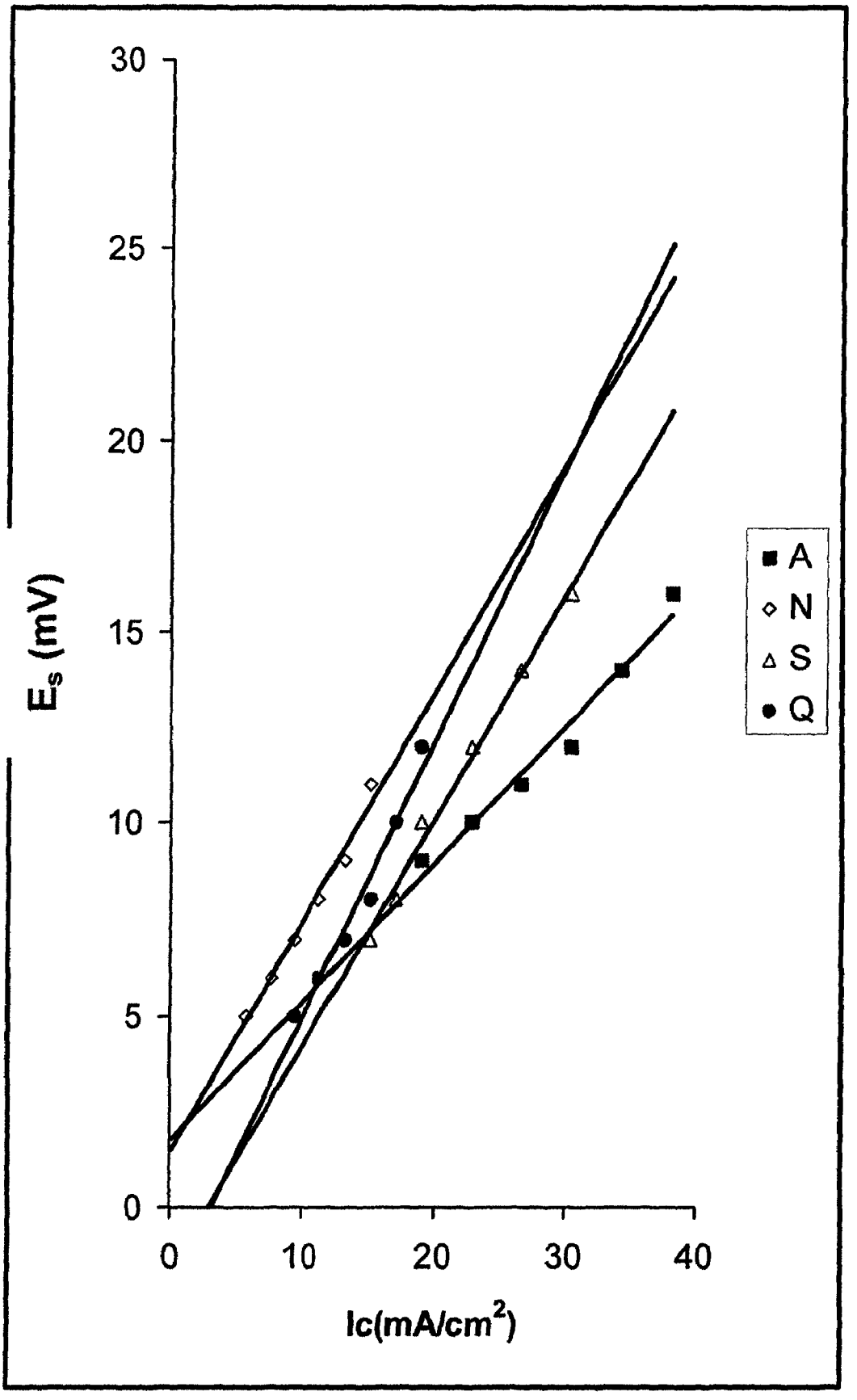
Fig(101): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 45 °C in presence of 6 x10^{-5}M HEAA



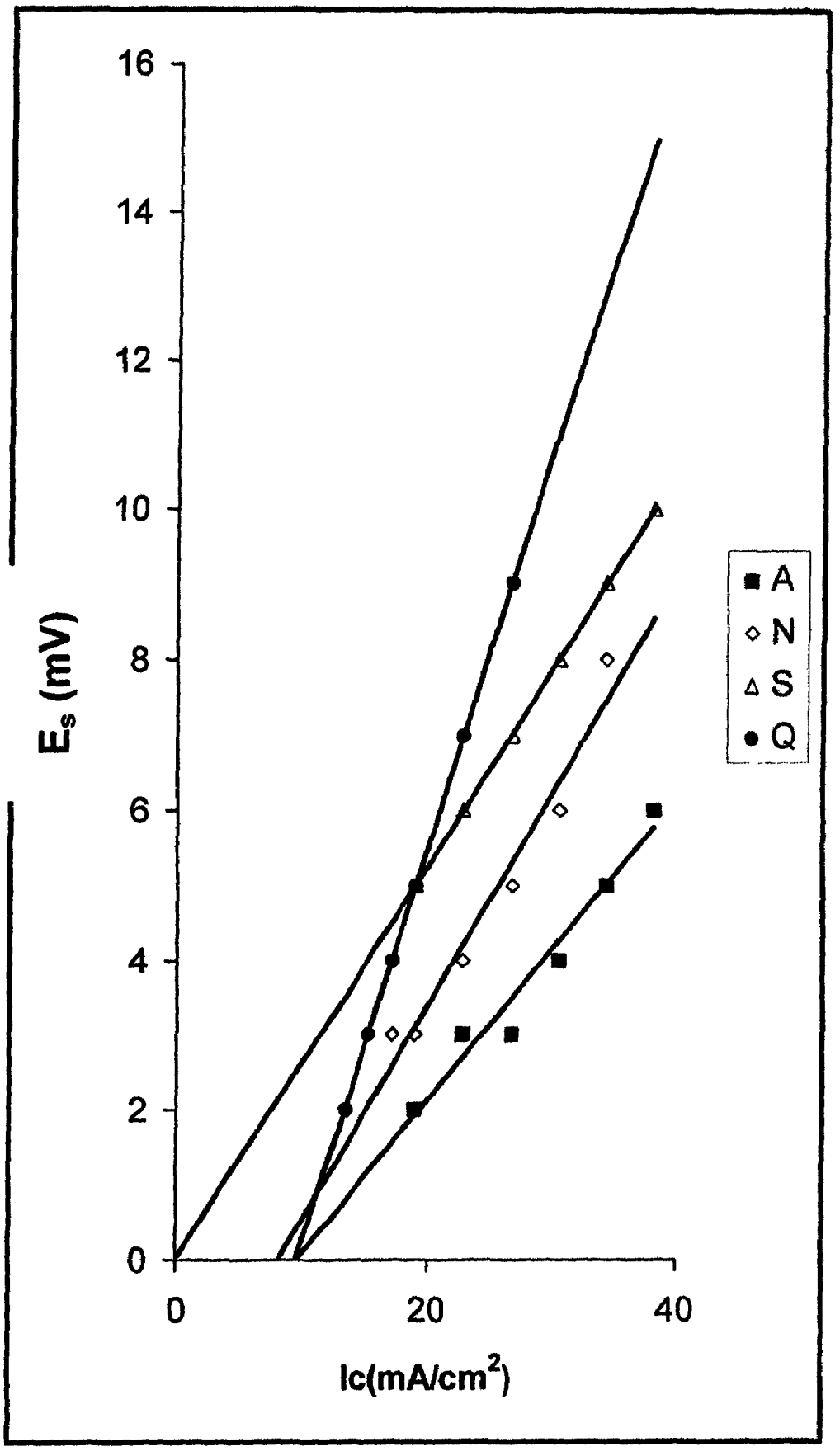
Fig(102): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 45 °C in presence of 8 x10^{-5}M HEAA



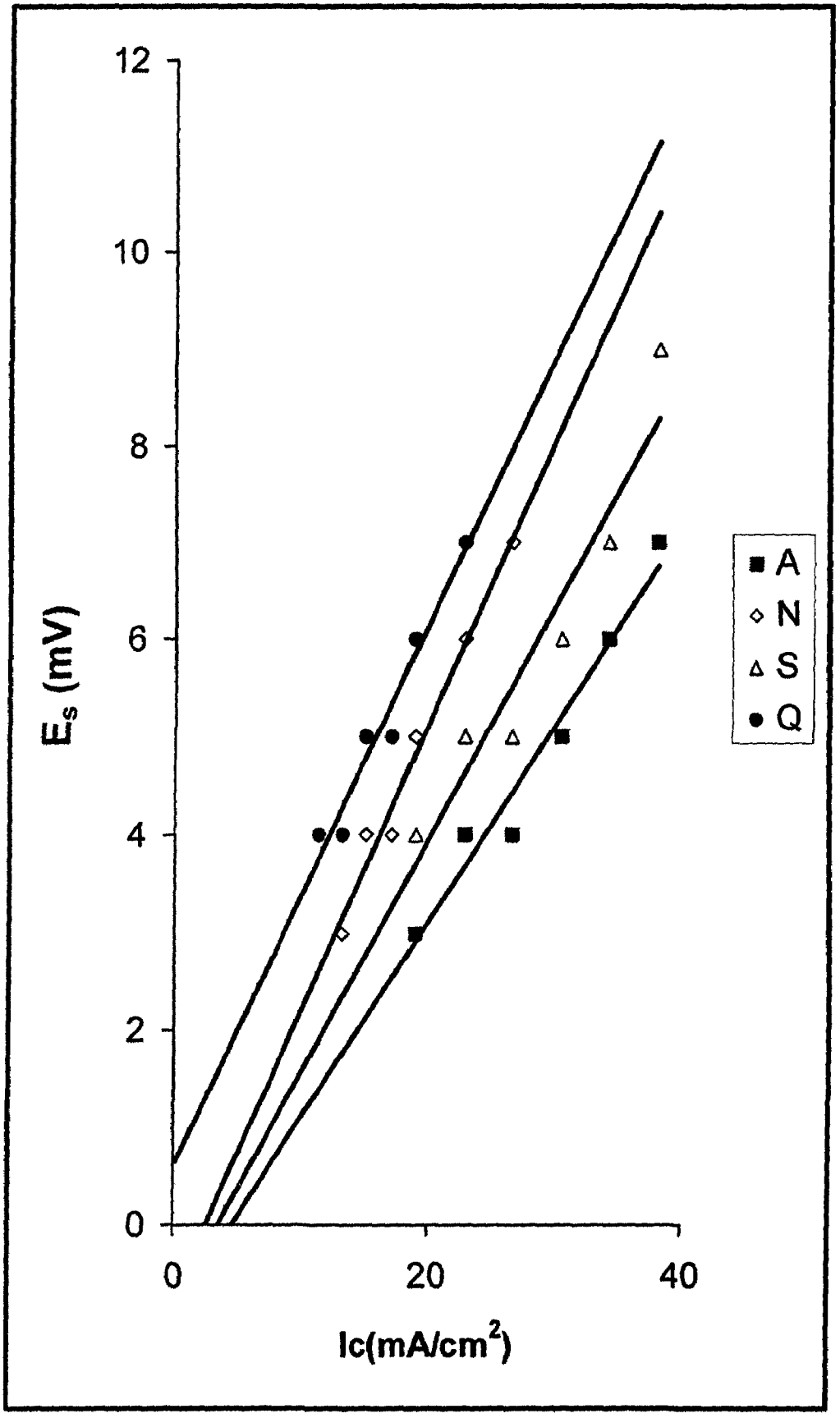
Fig(103): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 10^{-4}M HEAA



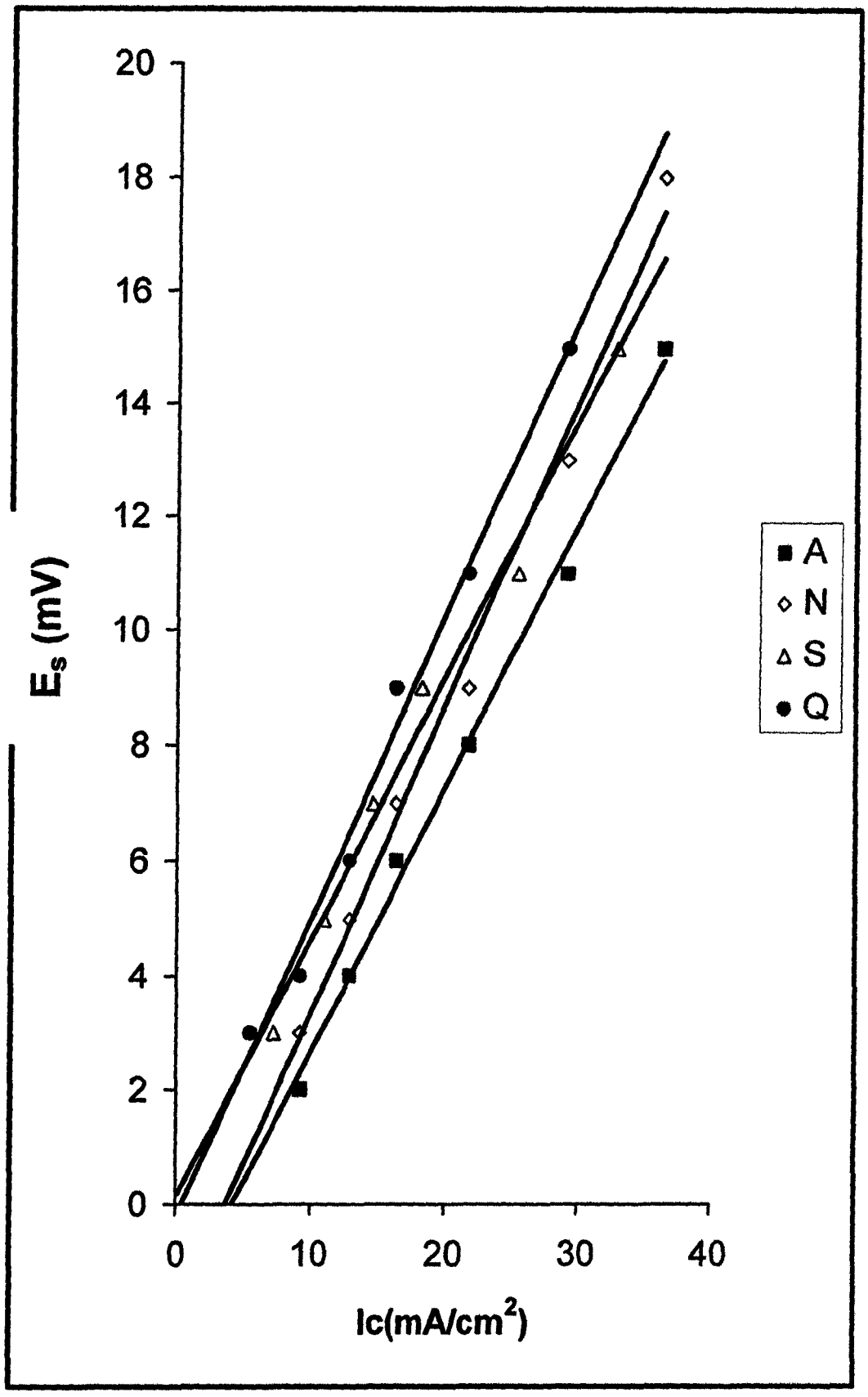
Fig(104): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1 M HNO_3 at 55 °C



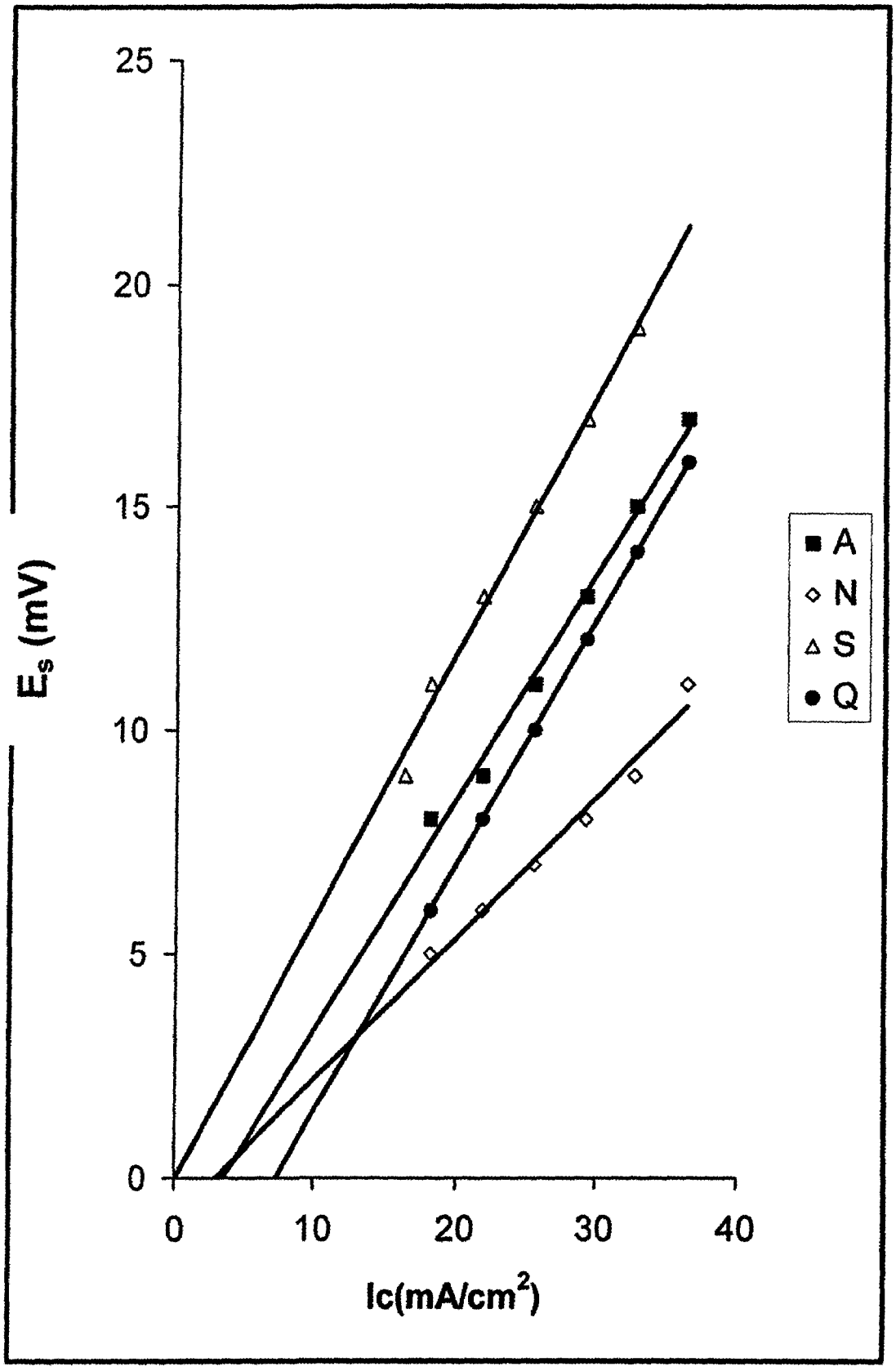
Fig(105): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.3 M HNO_3 at 55 °C



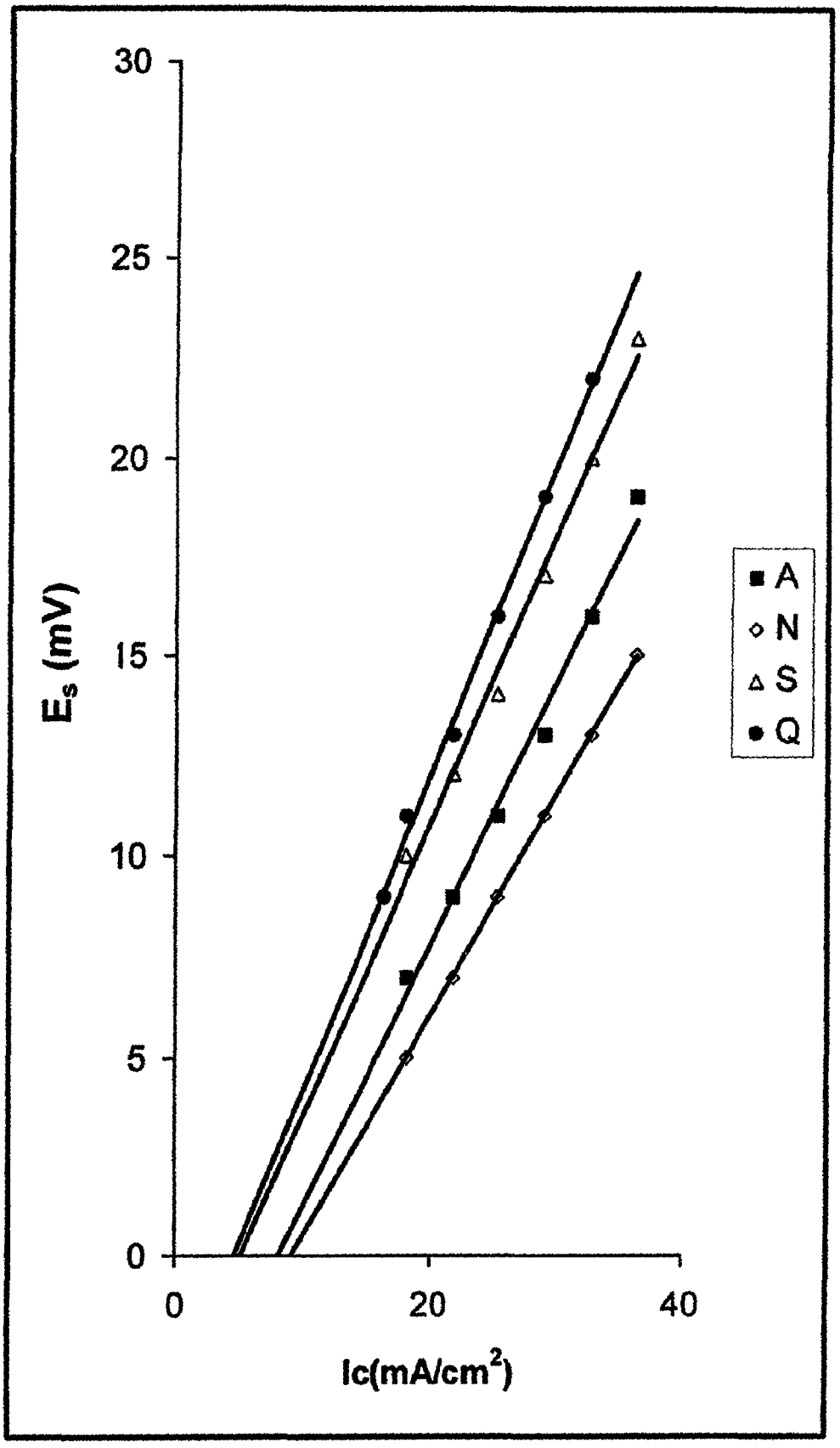
Fig(106): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.5 M HNO_3 at 55 °C



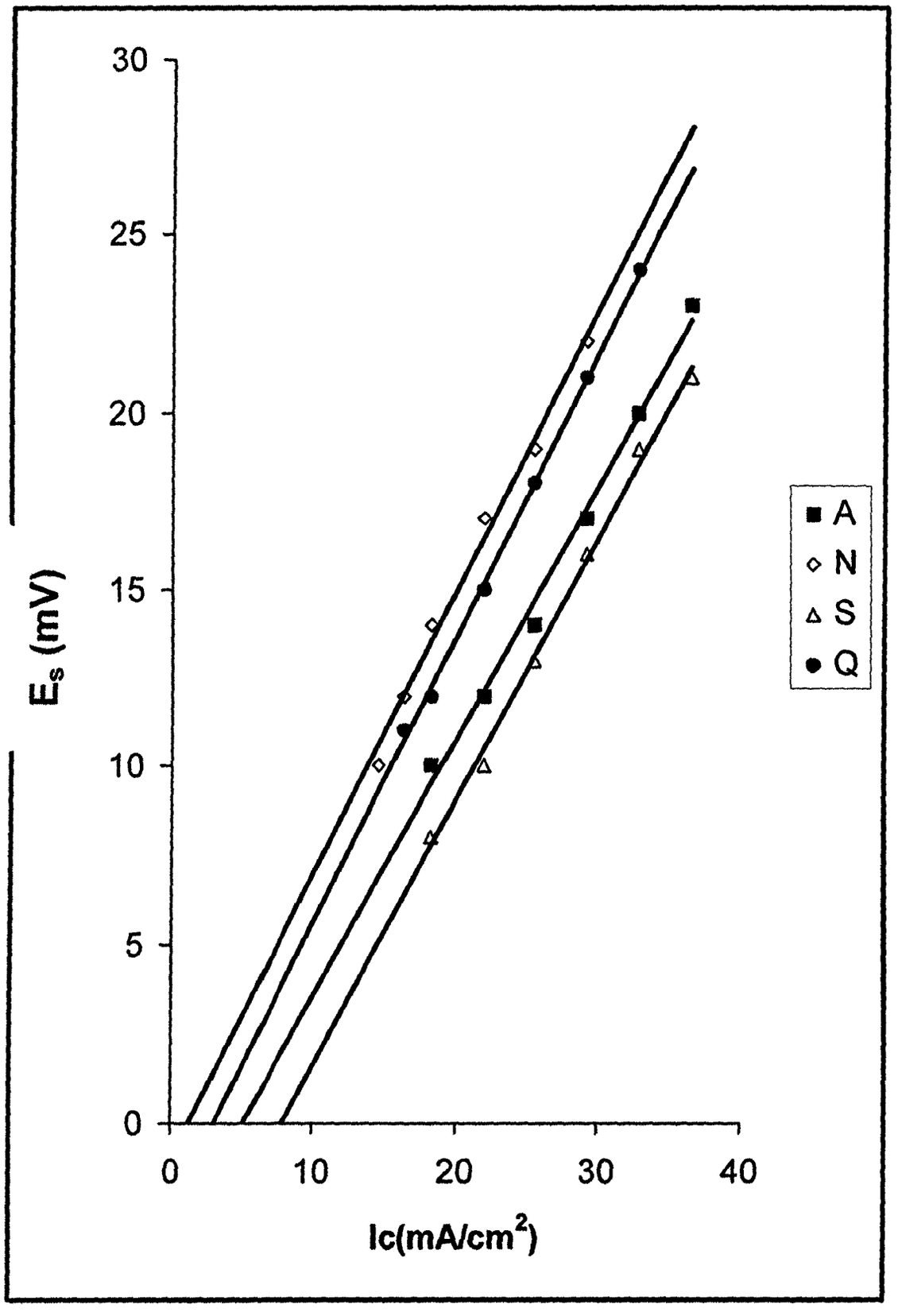
Fig(107): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 55 °C in presence of 2 x10^{-5}M HEAA



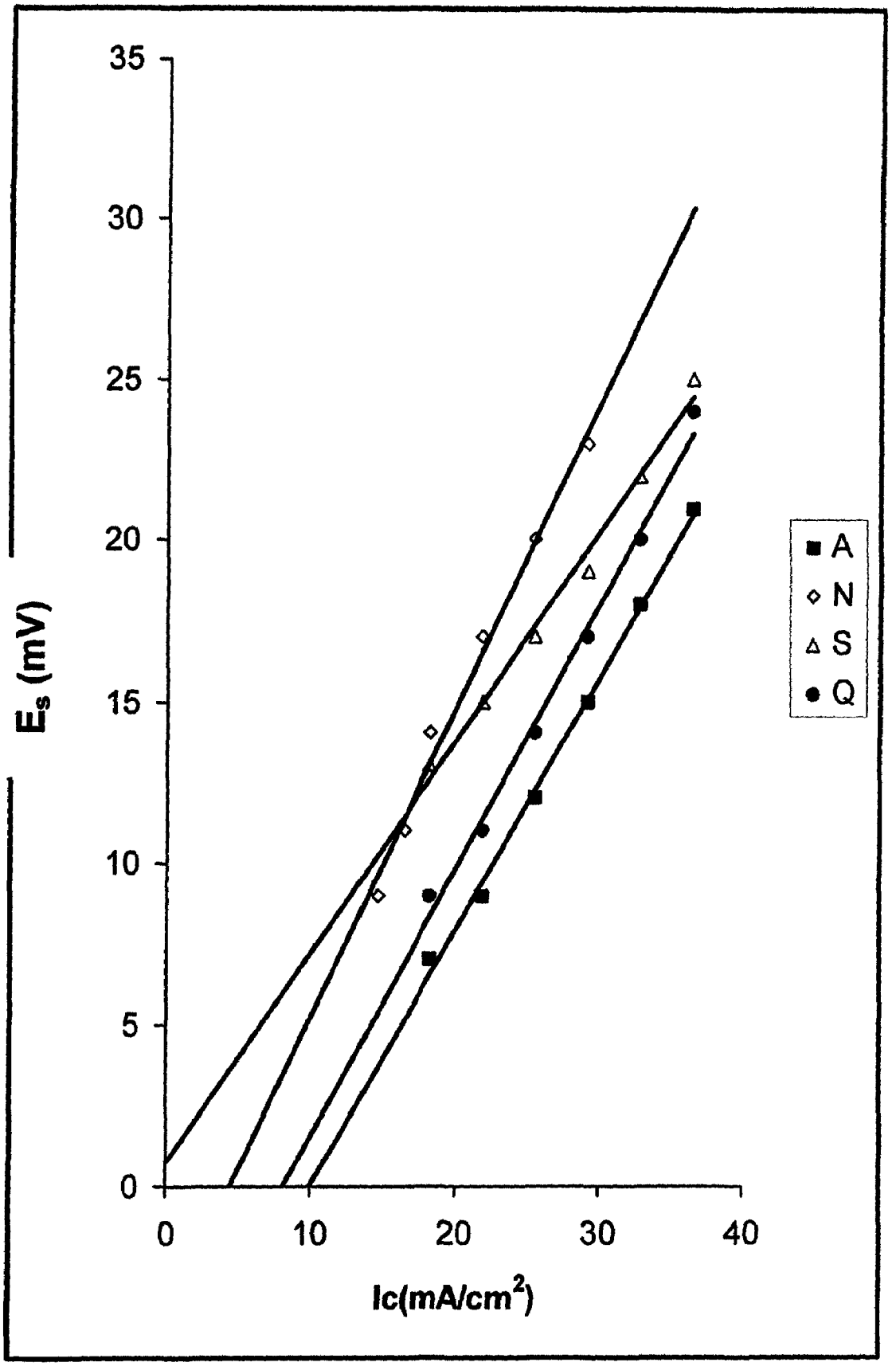
Fig(108): E_s values vs. cathodic current density (Ic)for L.C.V steel samples in 0.1M HNO_3 at 55 °C in presence of 4 x10^{-5}M HEAA



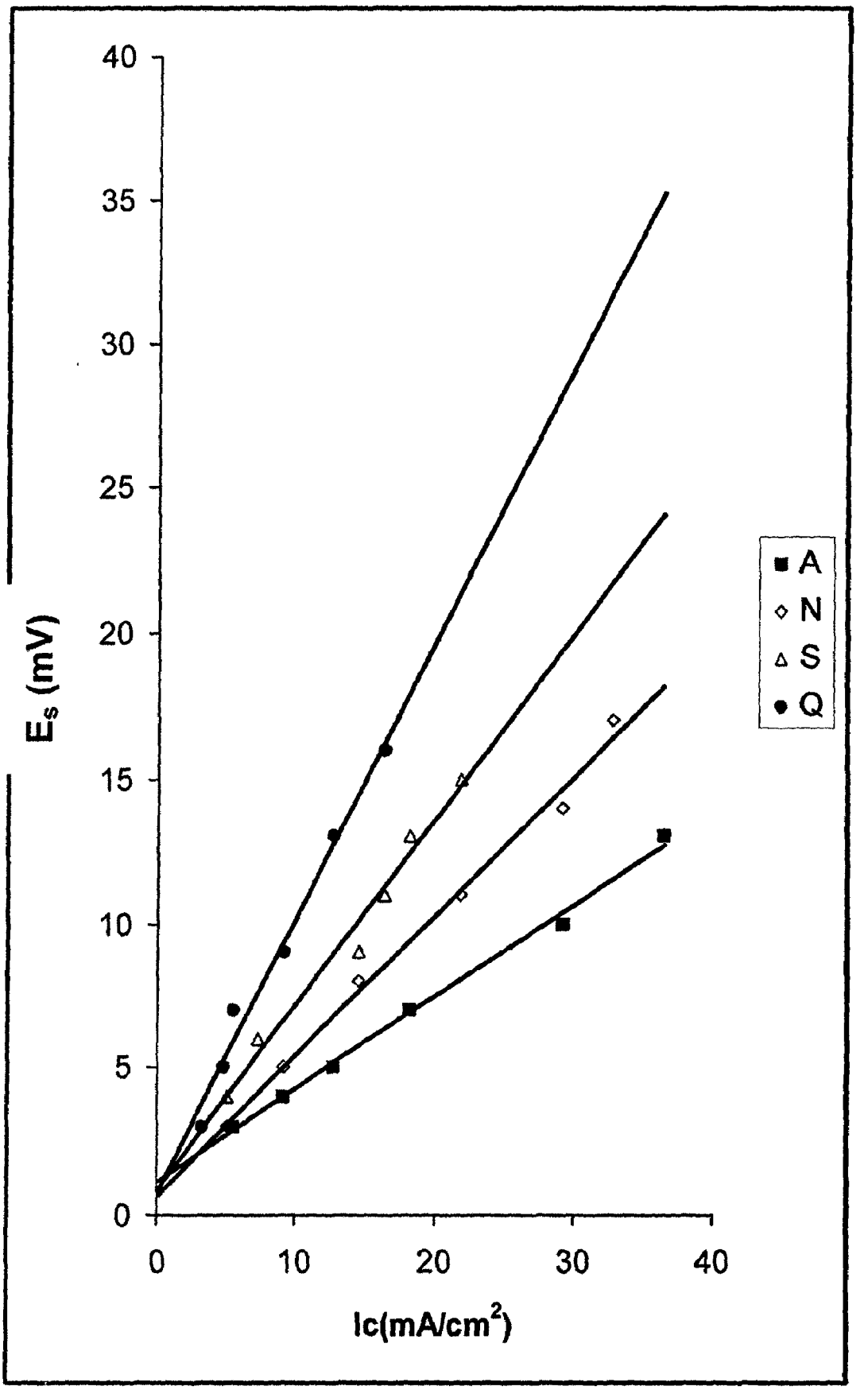
Fig(109): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 55 °C in presence of 6 x10^{-5}M HEAA



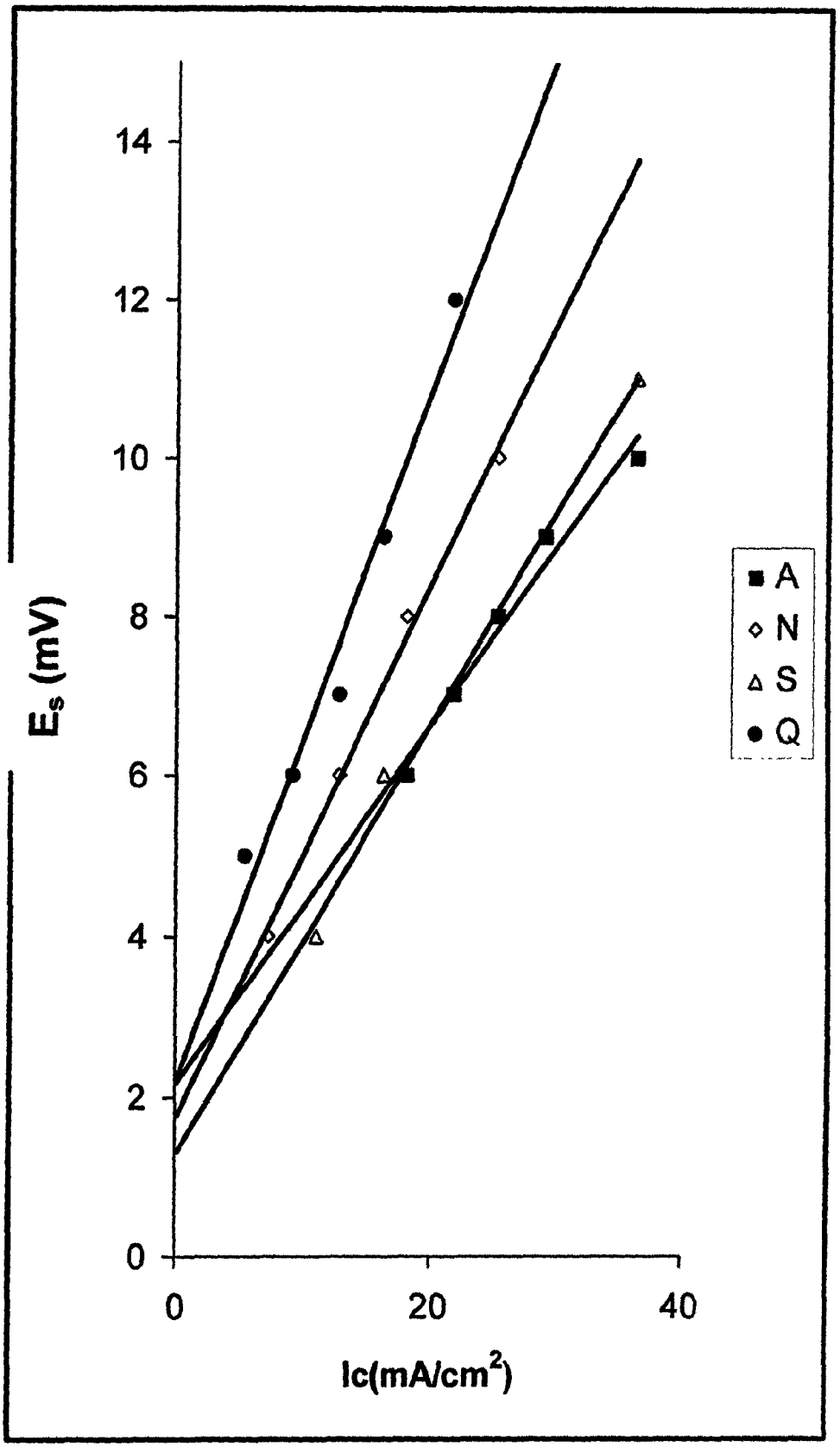
Fig(110): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 55 °C in presence of 8 x10^{-5}M HEAA



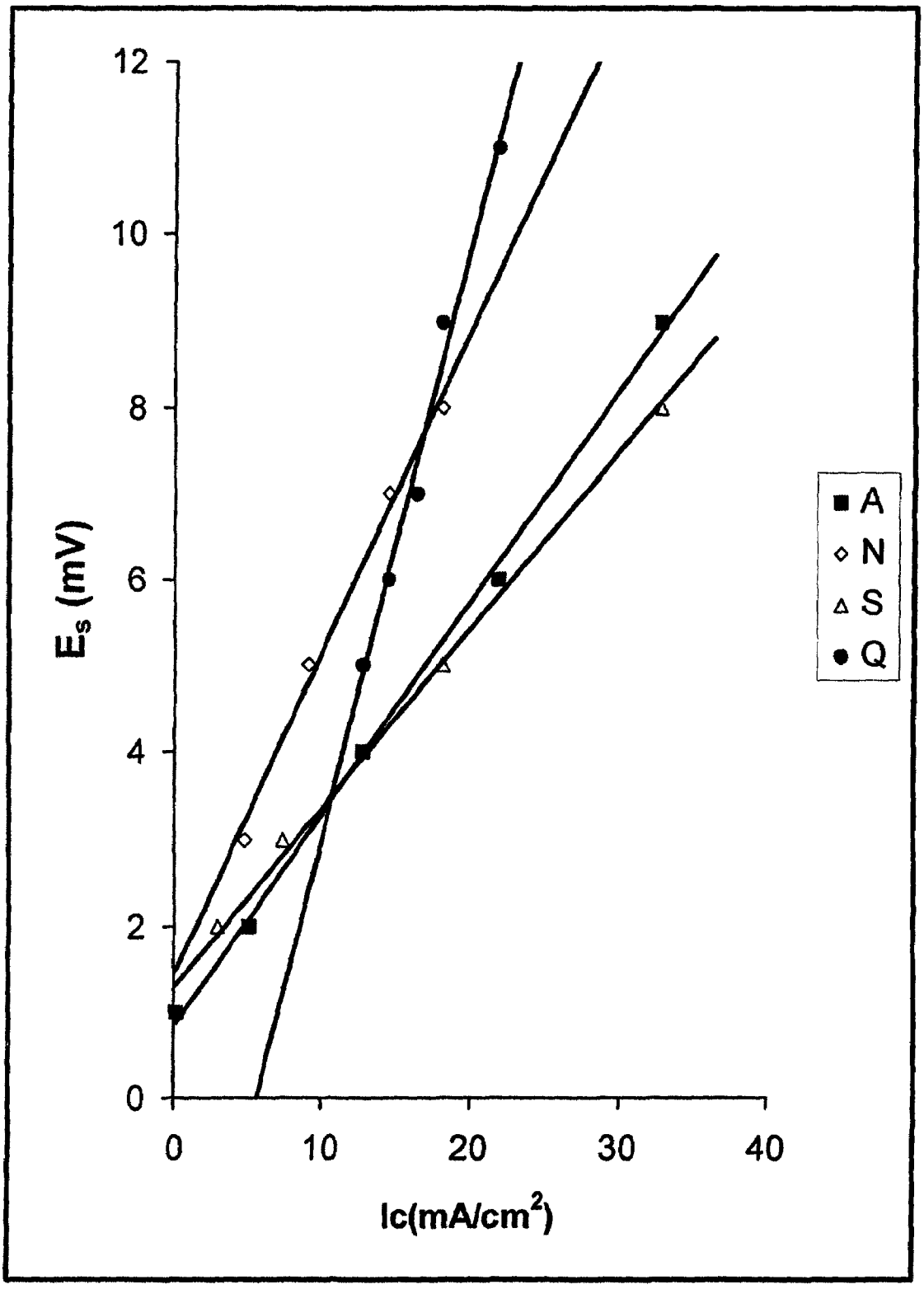
Fig(111): E_s values vs. cathodic current density (Ic)for L.C.V. steel samples in 0.1M HNO_3 at 55 °C in presence of 10^{-4}M HEAA



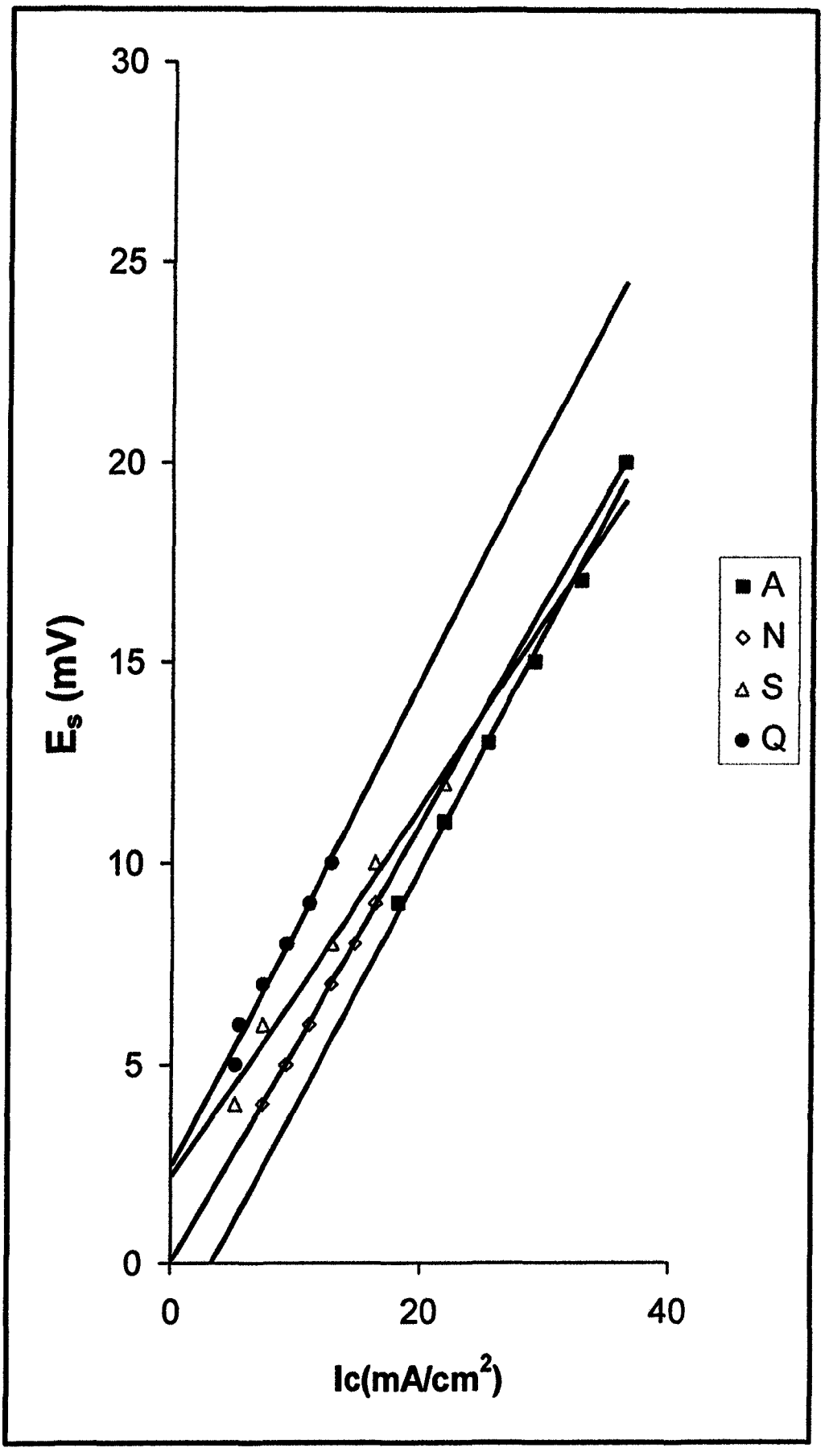
Fig(112): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 25 °C



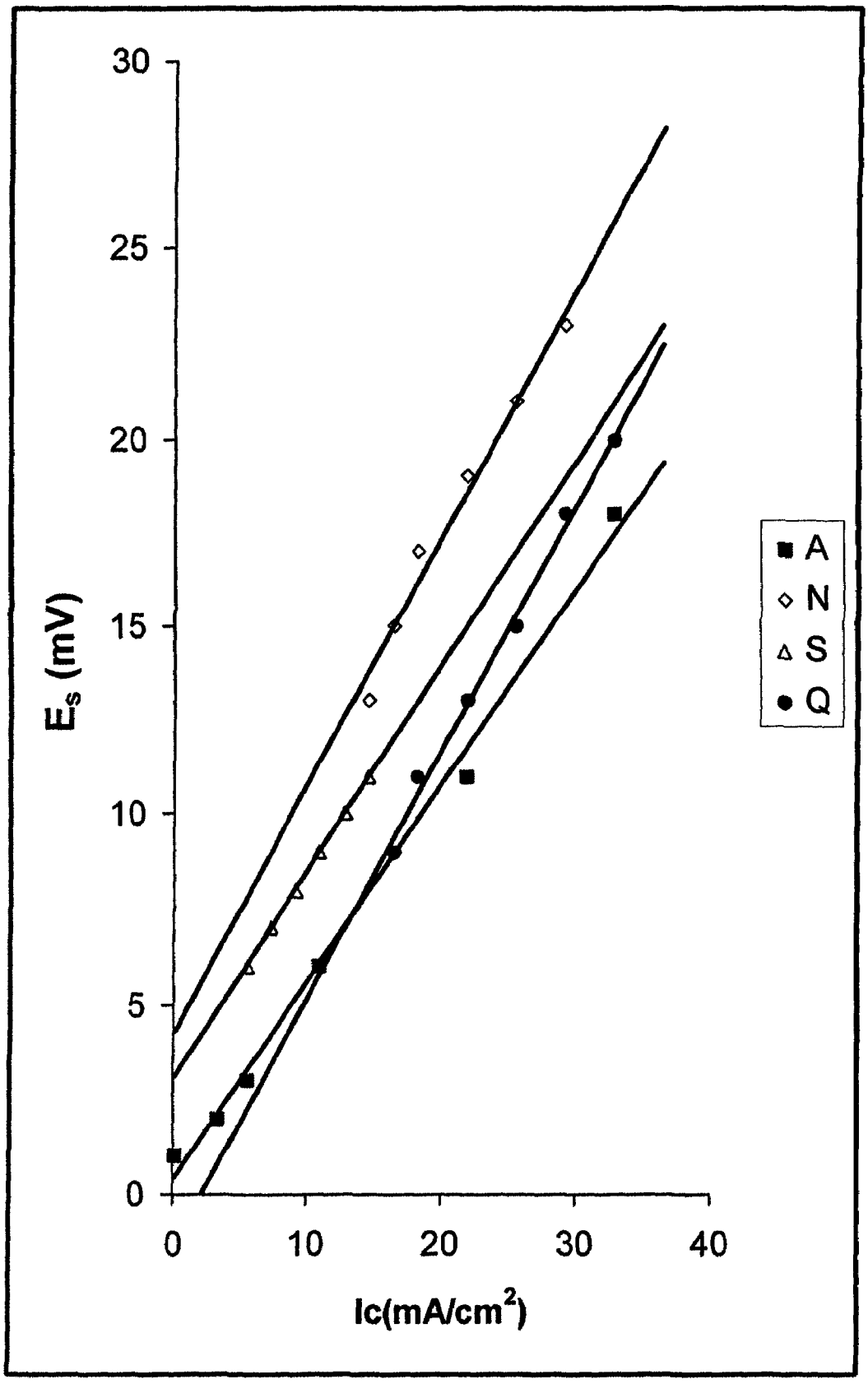
Fig(113): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.3 M HNO_3 at 25 °C



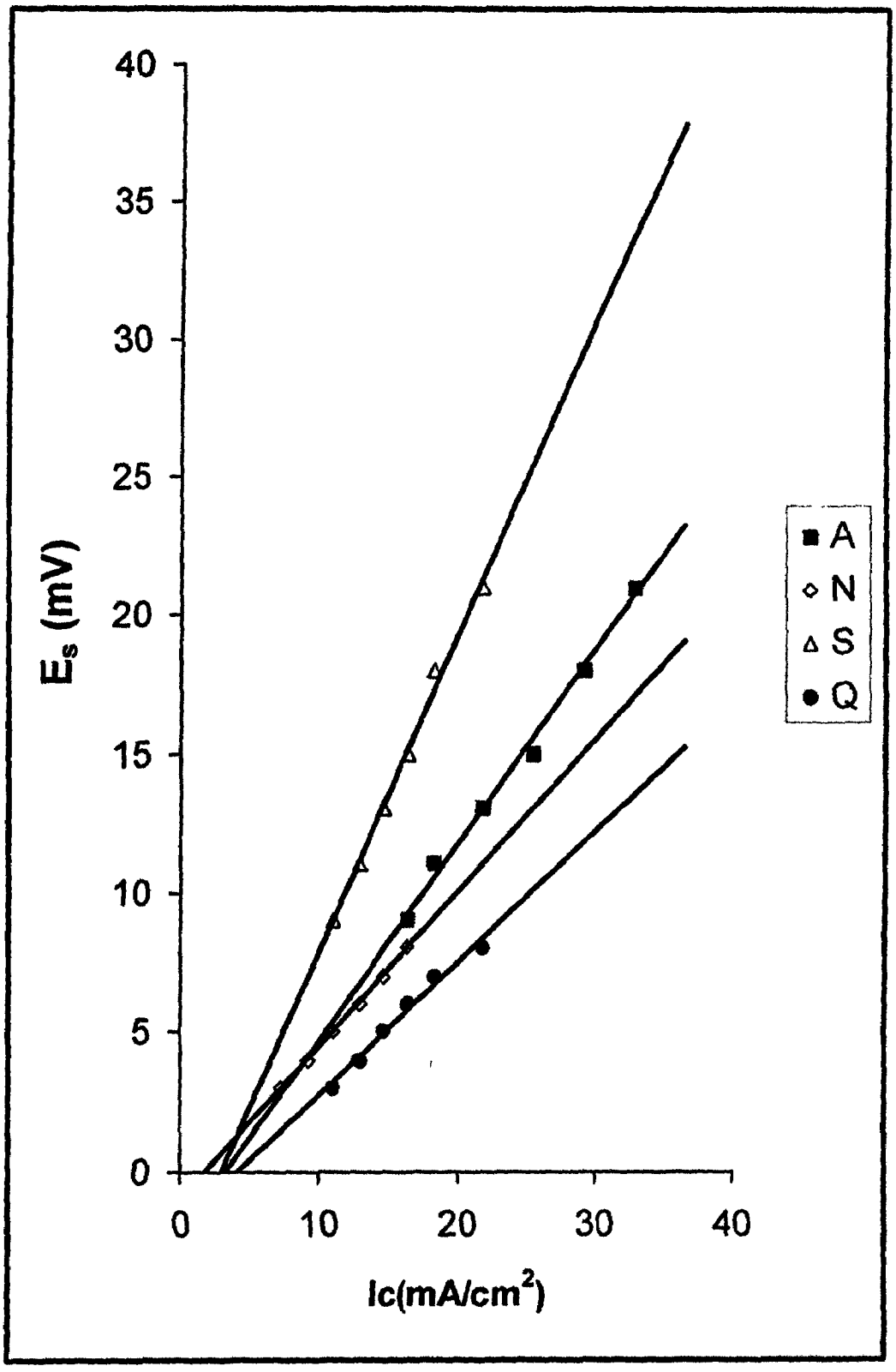
Fig(114): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.5 M HNO_3 at 25 °C



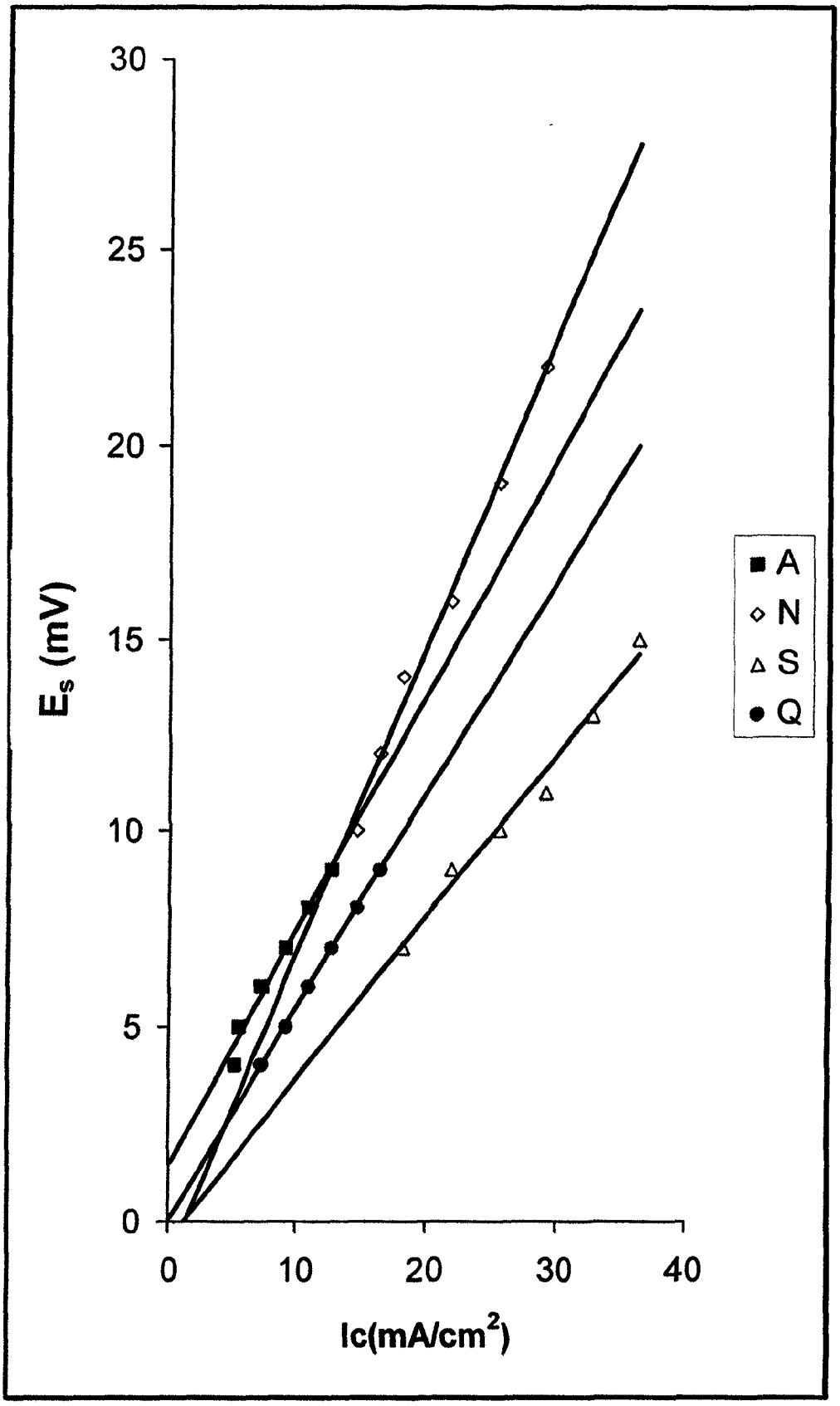
Fig(115): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1 M HNO_3 at 25 °C in presence of 2 x10^{-5}M HEAA



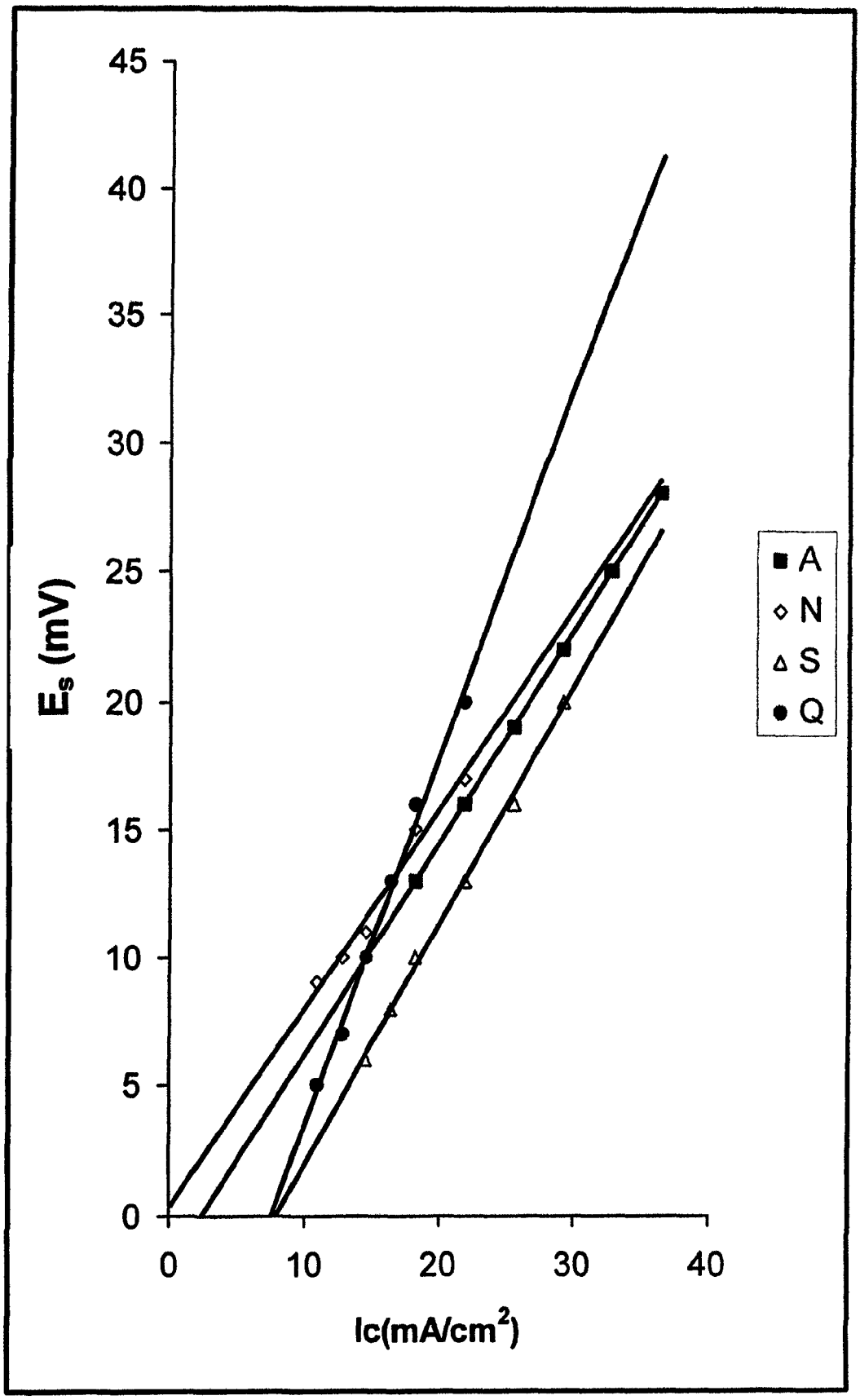
Fig(116): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 4 x10^{-5}M HEAA



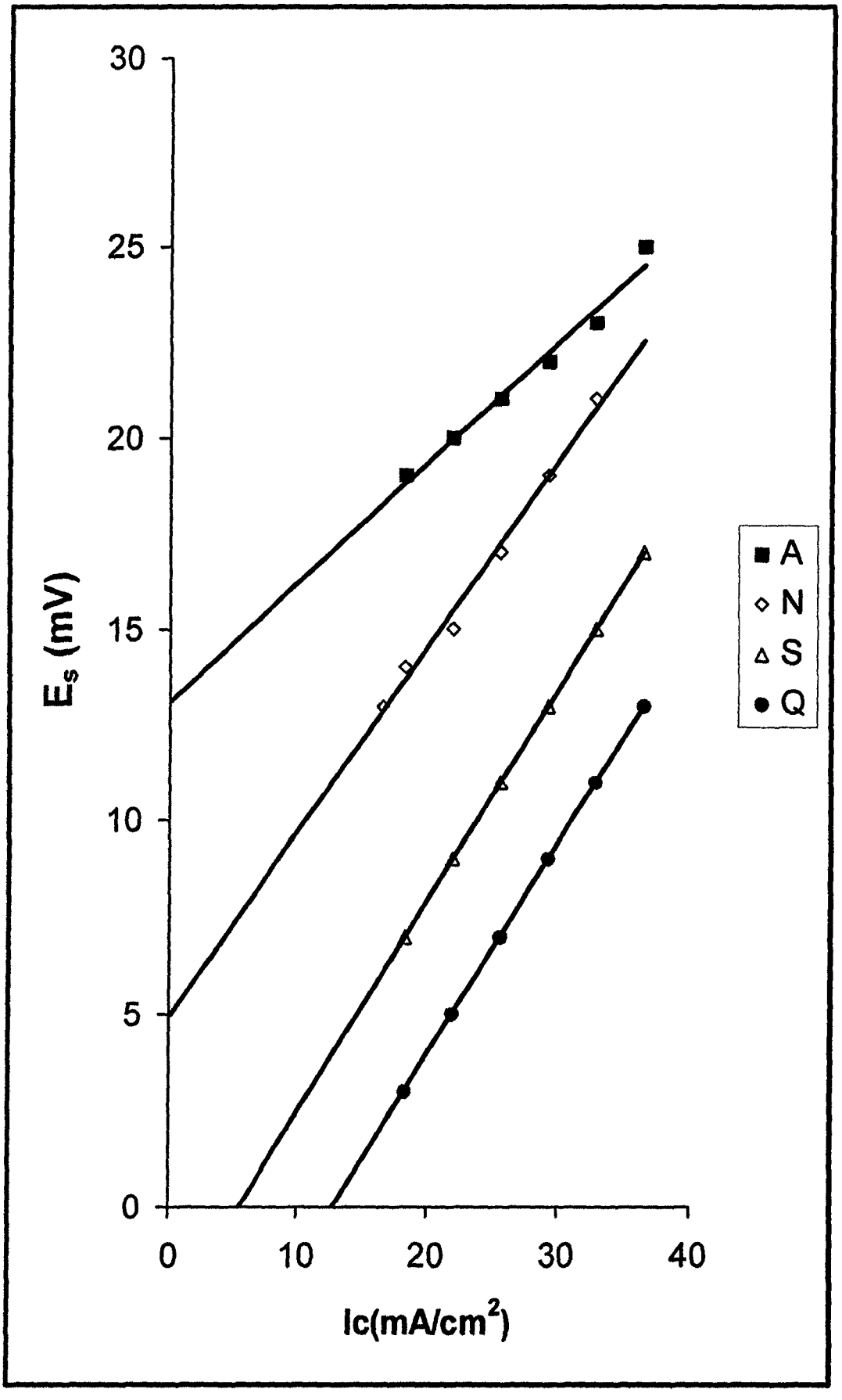
Fig(117): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 6 x10^{-5}M HEAA



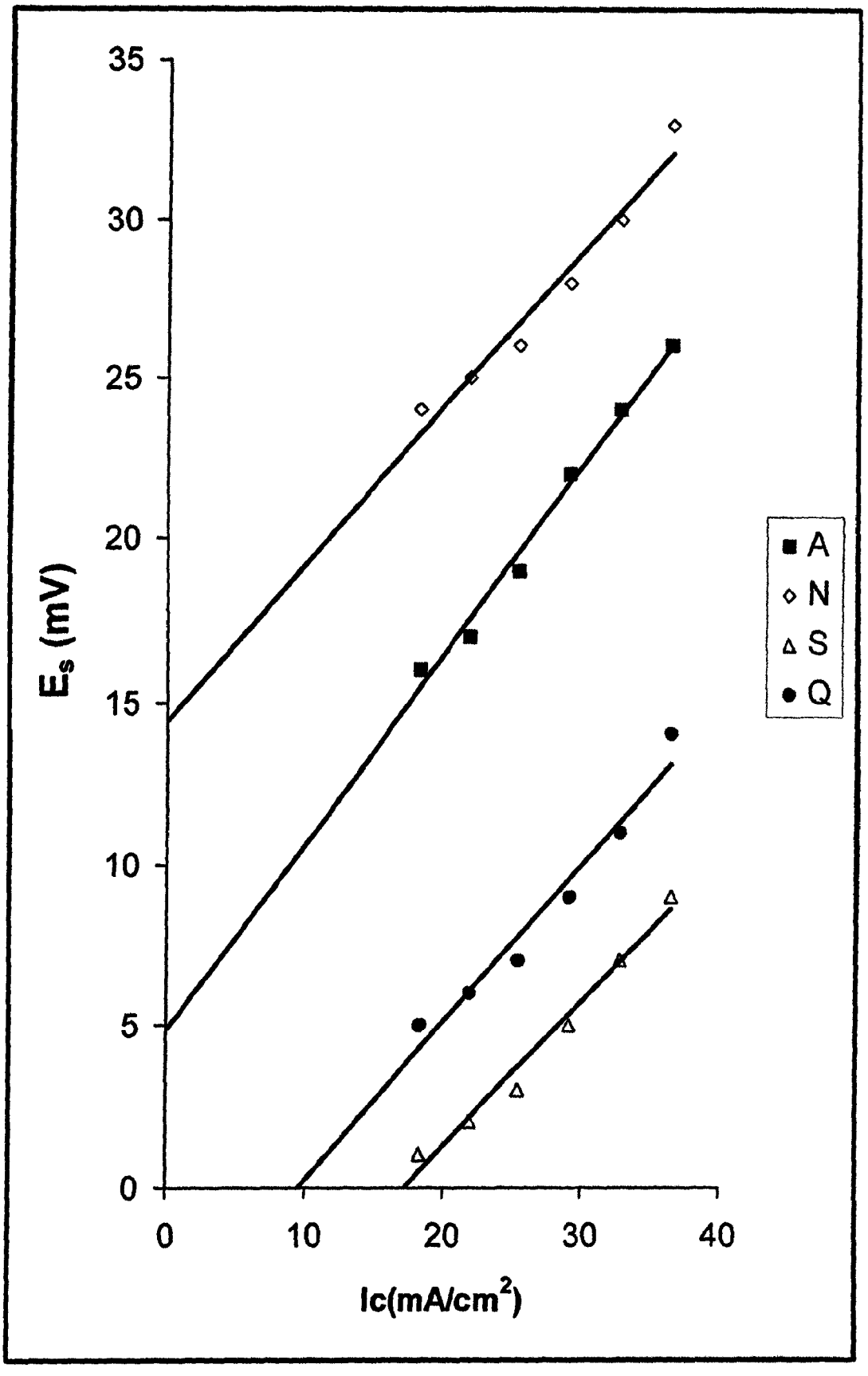
Fig(118): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 8 x10^{-5}M HEAA



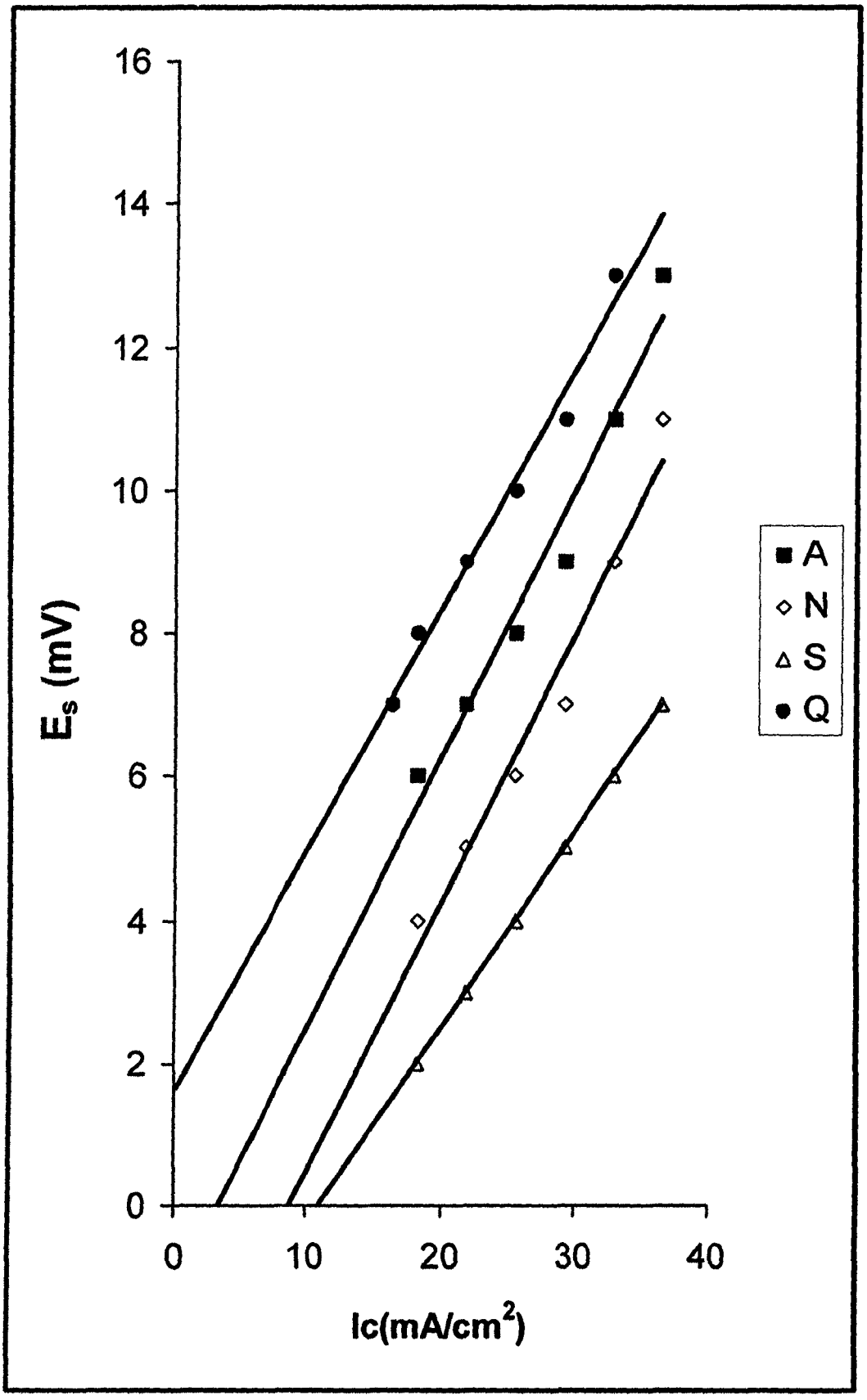
Fig(119): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.1 M HNO_3 at 25 °C in presence of 10^{-4}M HEAA



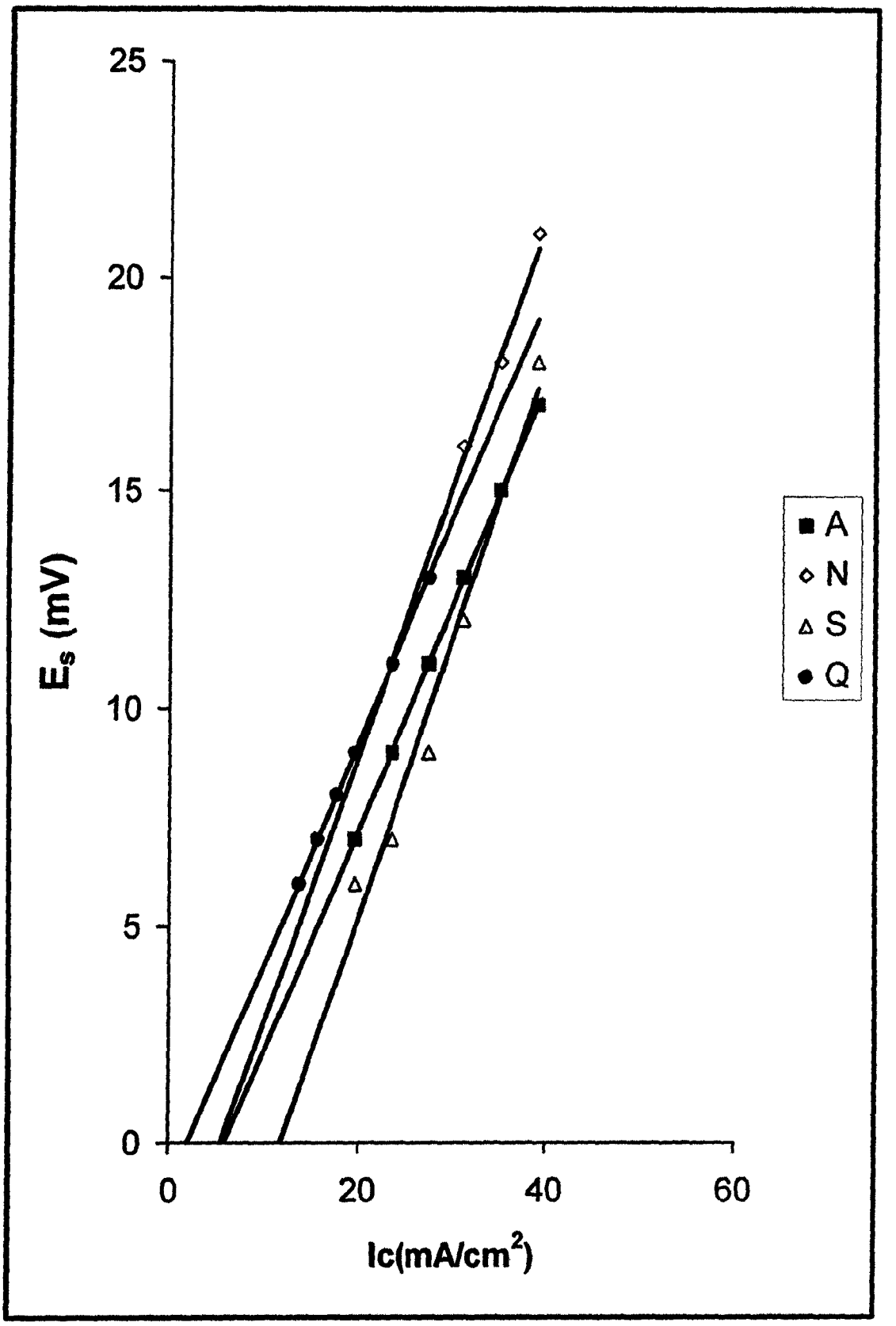
Fig(120): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1 M HNO_3 at 35 °C



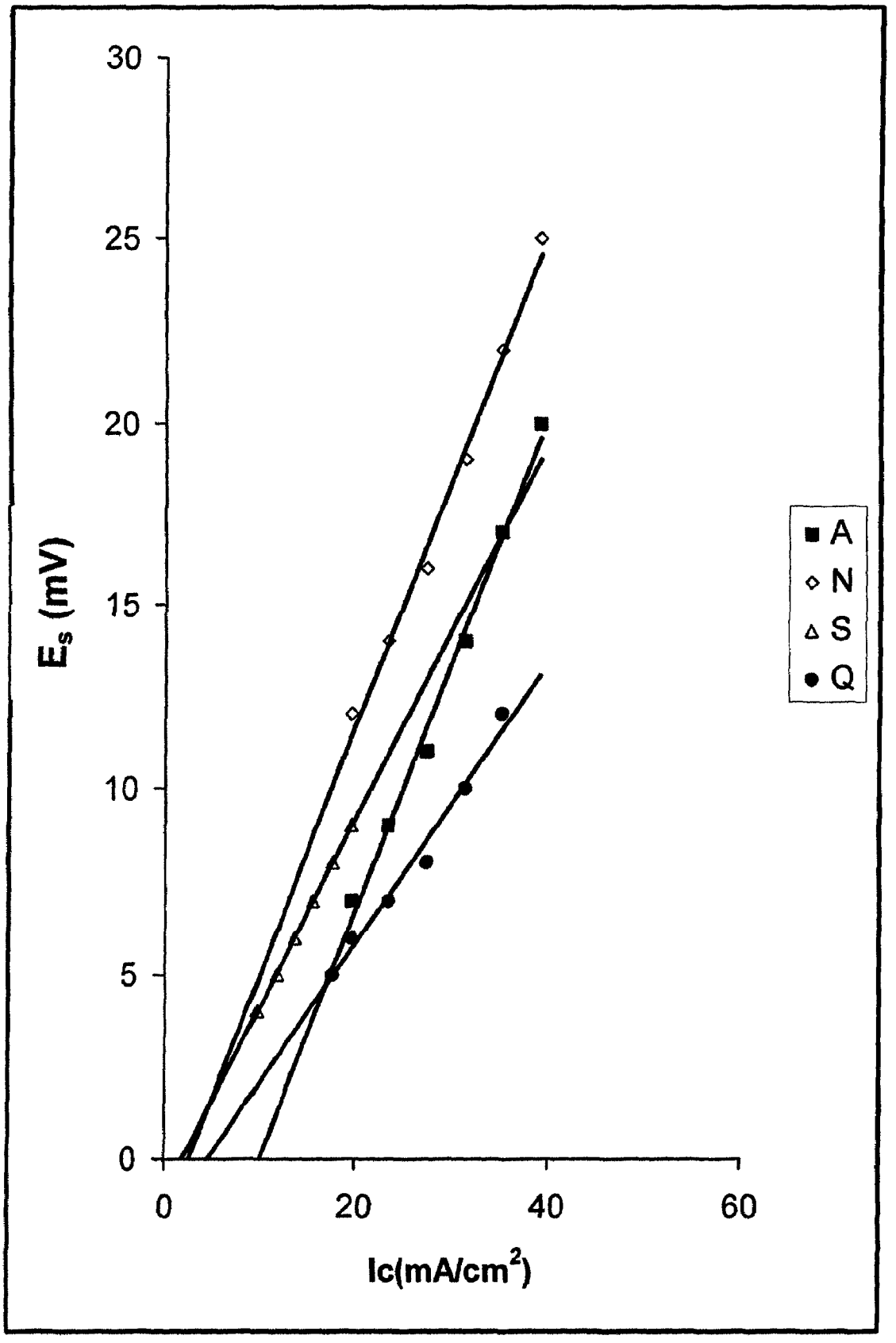
Fig(121): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.3 M HNO_3 at 35 °C



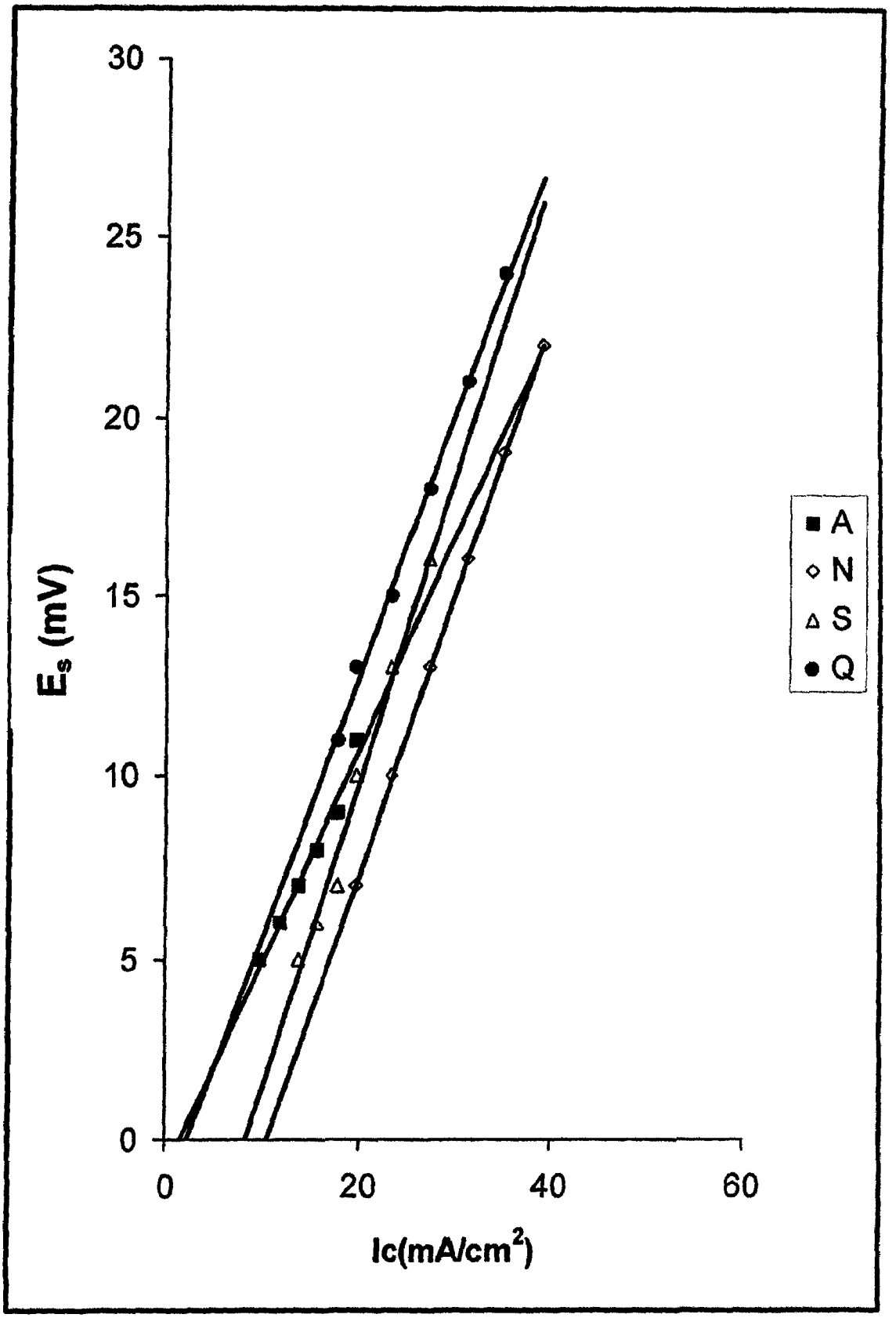
Fig(122): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.5 M HNO_3 at 35 °C



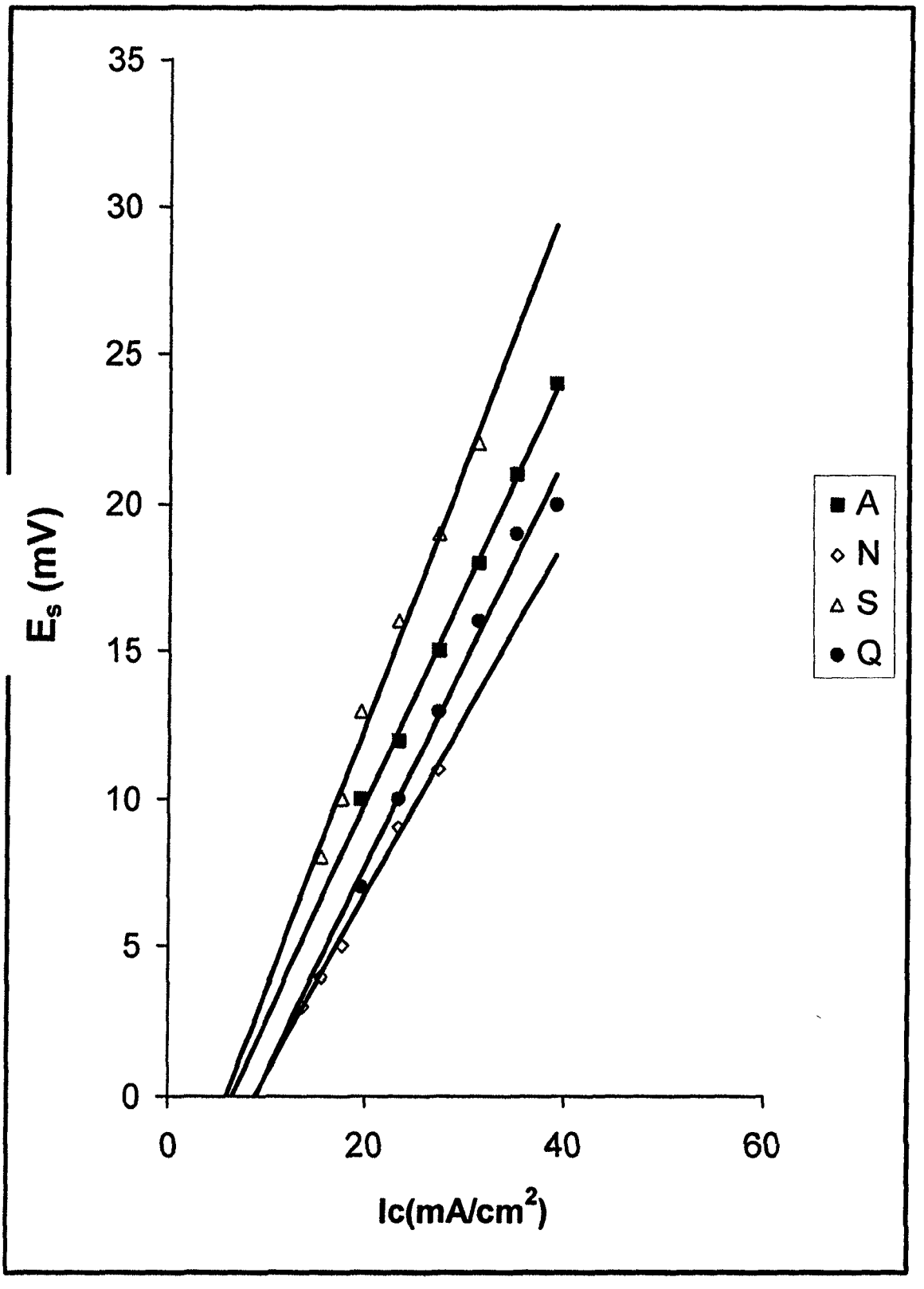
Fig(123): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 35 °C in presence of 2 x10^{-5} M HEAA



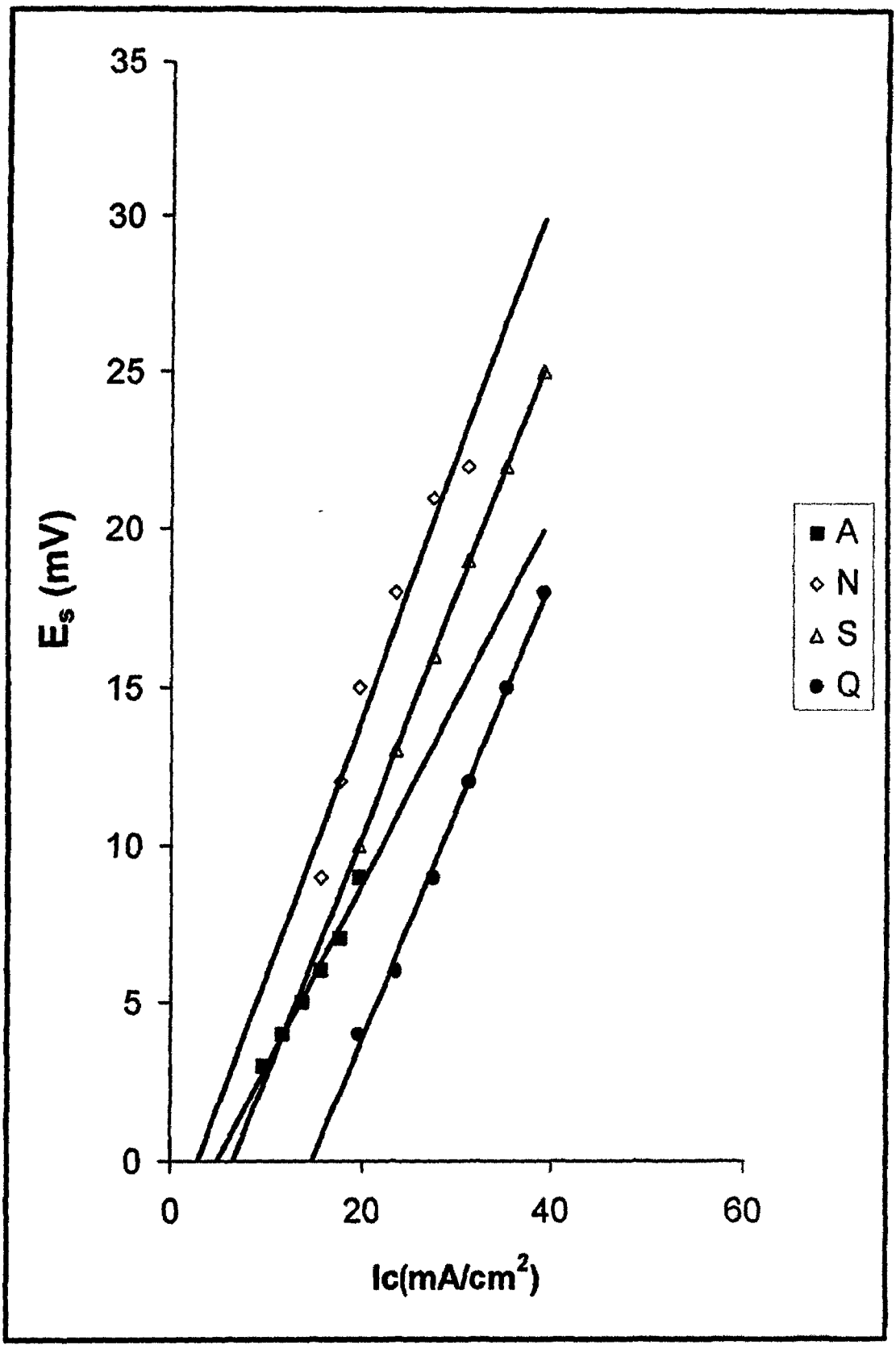
Fig(124): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 35 °C in presence of 4 x10^{-5} M HEAA



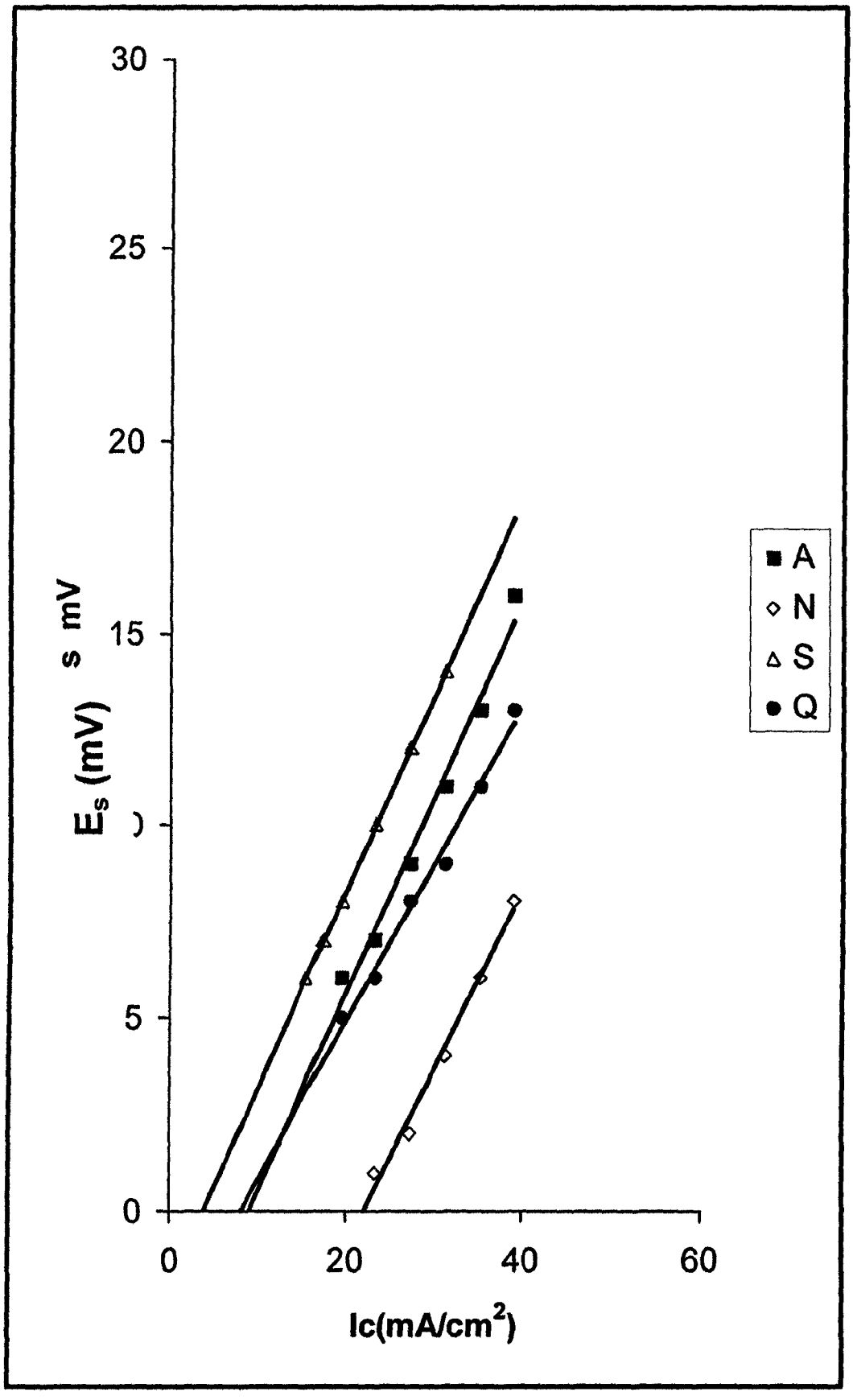
Fig(125): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.1M HNO_3 at 35 °C in presence of 6 x10^{-5} M HEAA



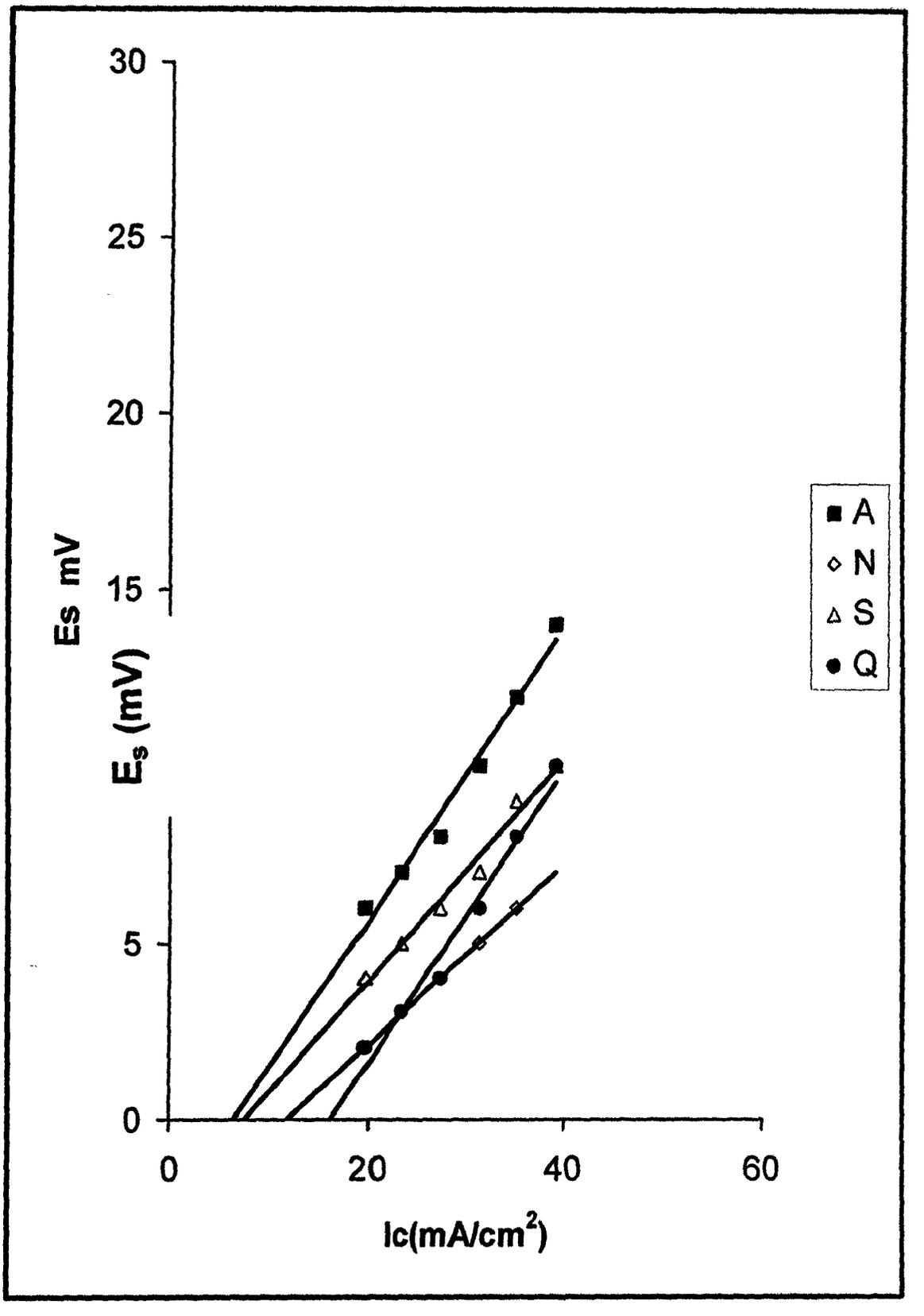
Fig(126): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 35 °C in presence of 8 x10^{-5} M HEAA



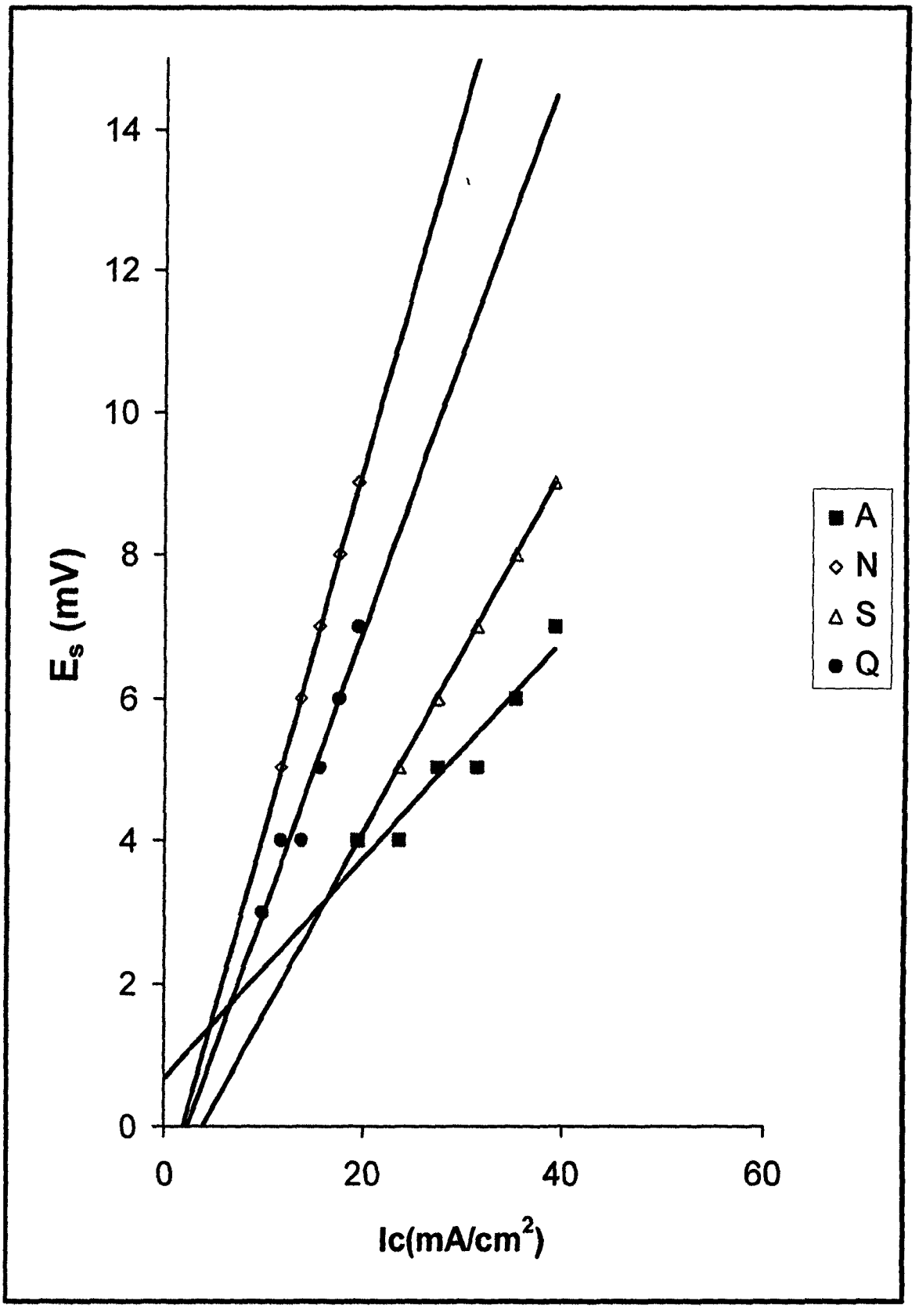
Fig(127): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.1M HNO_3 at 35 °C in presence of 10^{-4} M HEAA



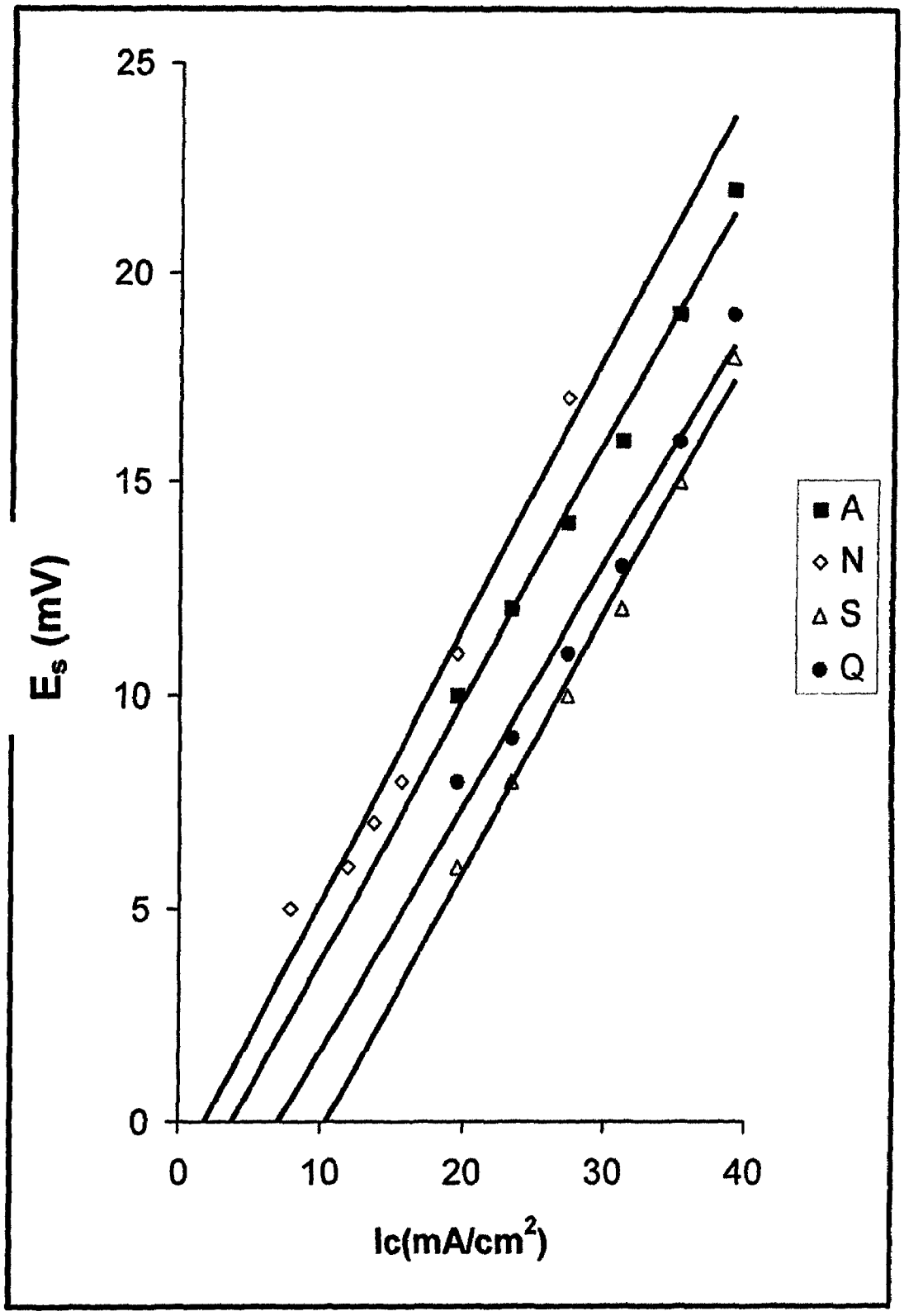
Fig(128): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 45 °C



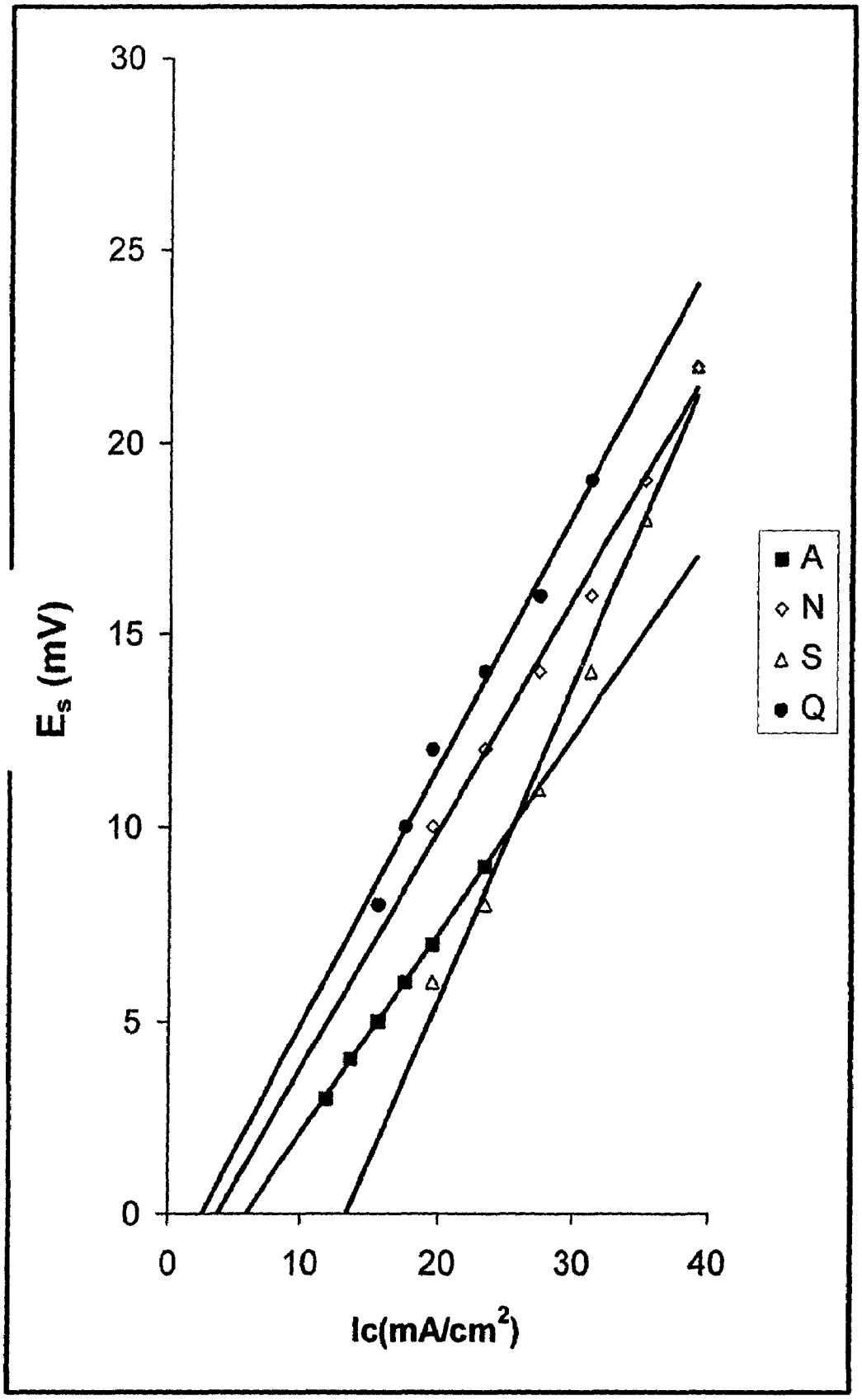
Fig(129): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.3M HNO_3 at 45 °C



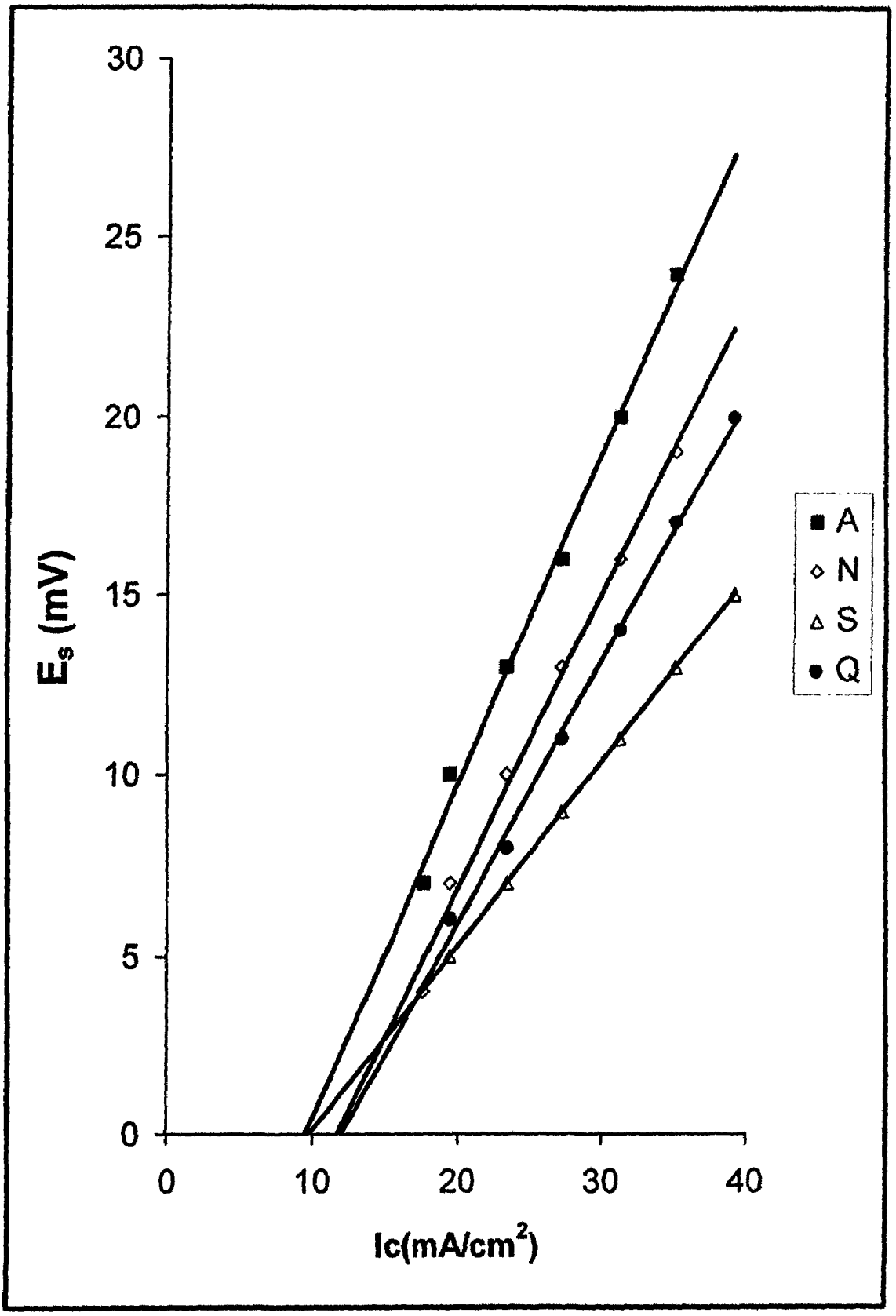
Fig(130): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.5M HNO_3 at 45 °C



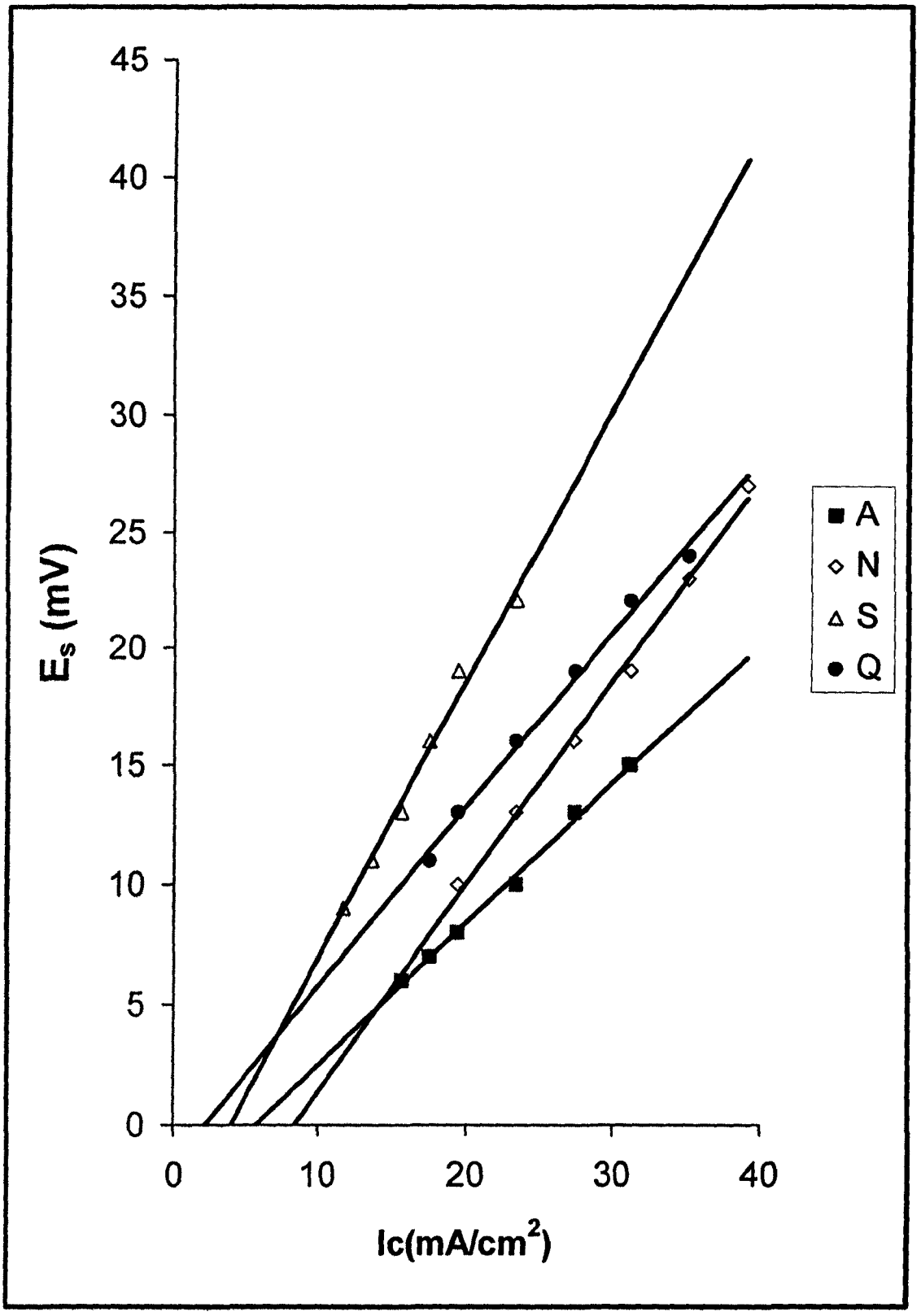
Fig(131): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 2×10^{-5} M HEAA



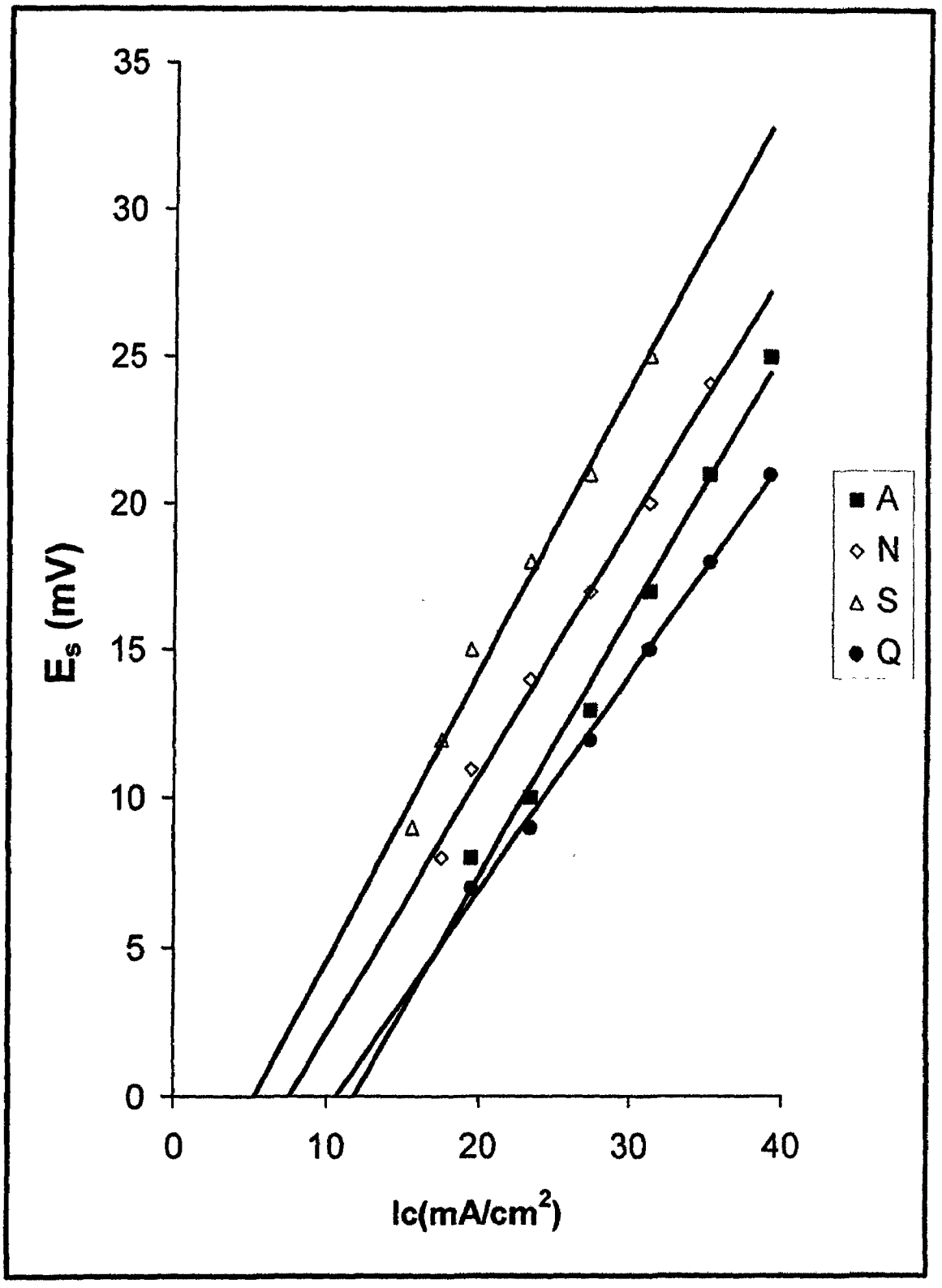
Fig(132): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 4 x10^{-5} M HEAA



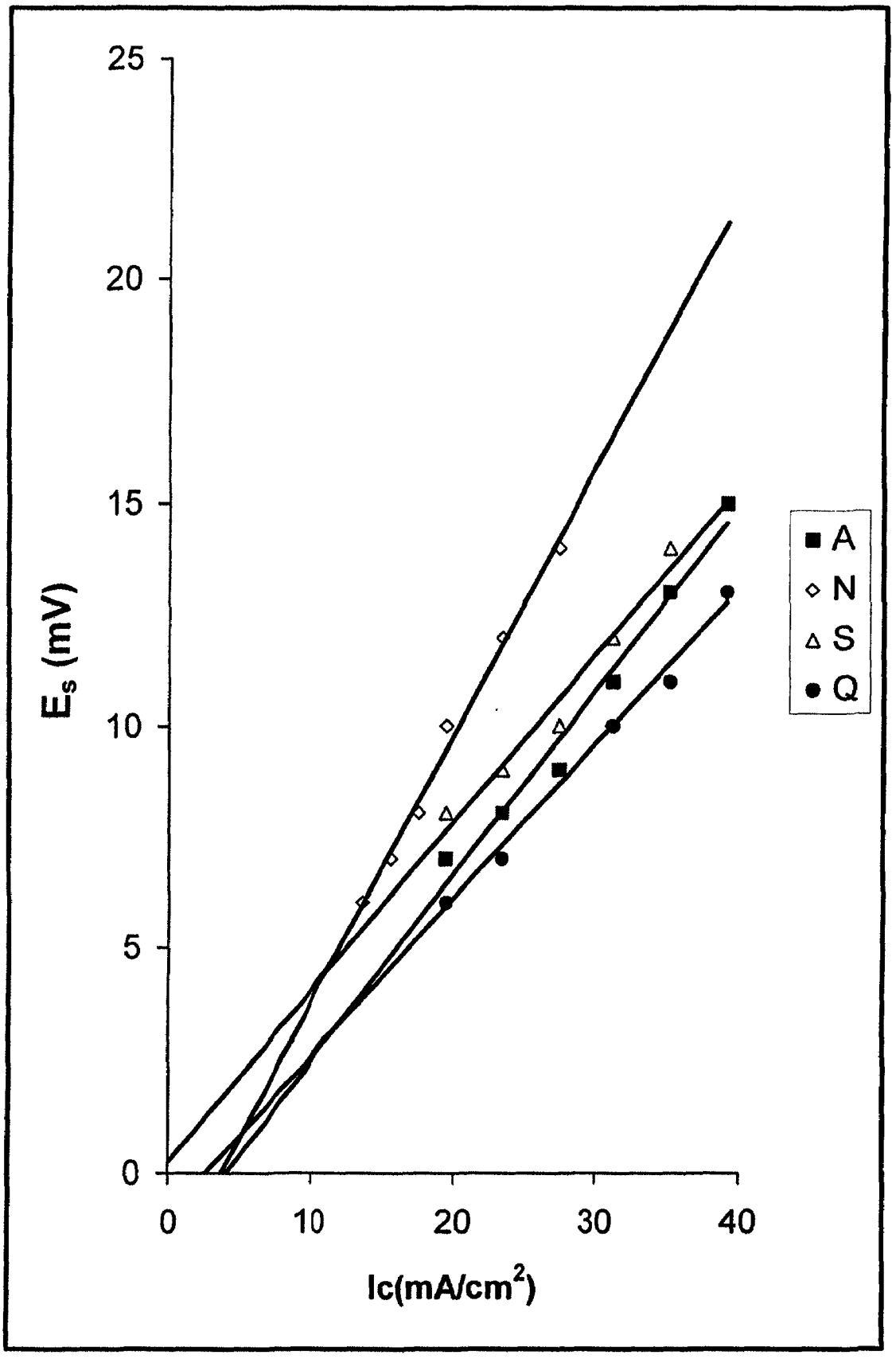
Fig(133): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 6 x10^{-5} M HEAA



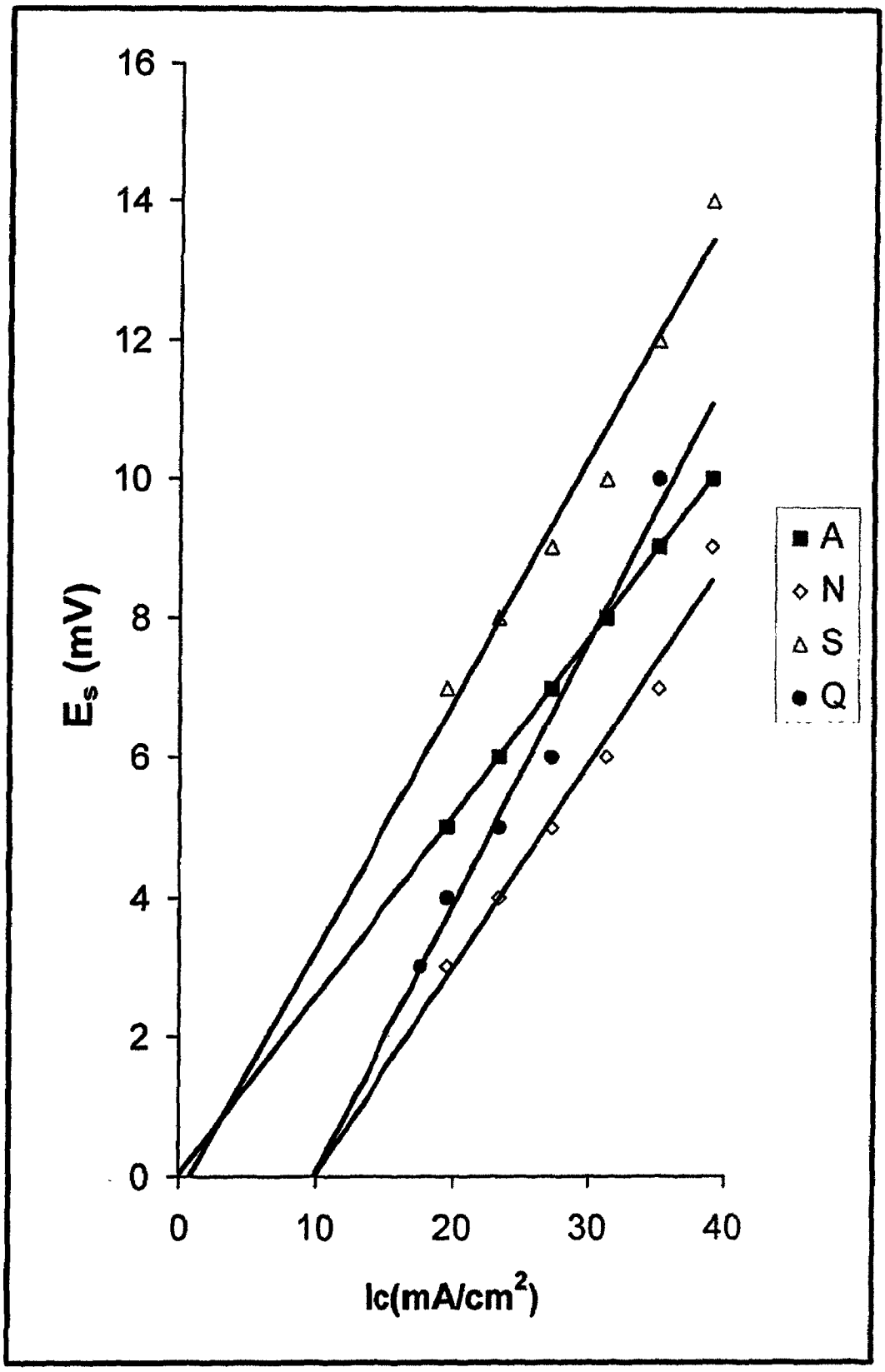
Fig(134): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 8 x10^{-5} M HEAA



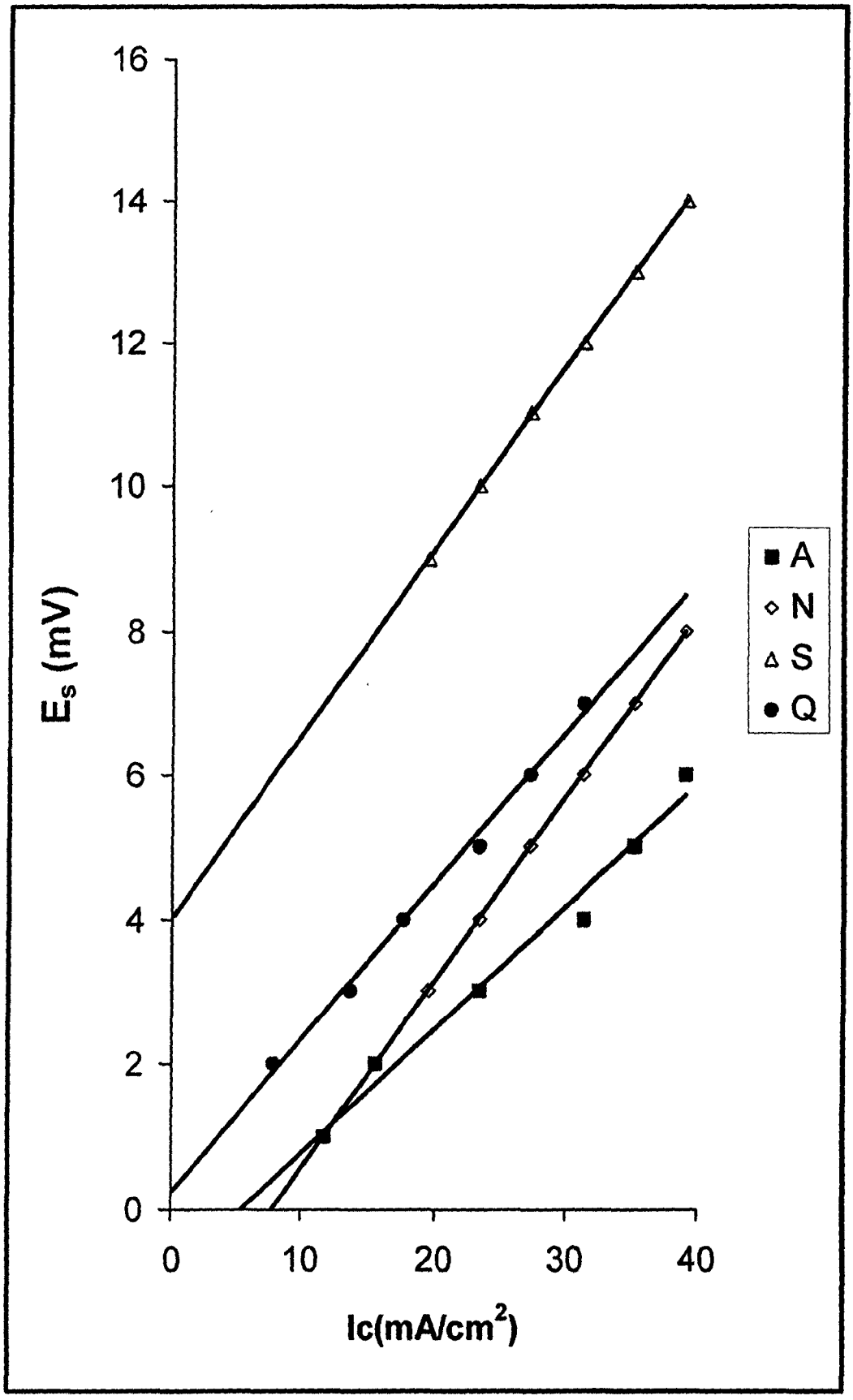
Fig(135): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 45 °C in presence of 10^{-4} M HEAA



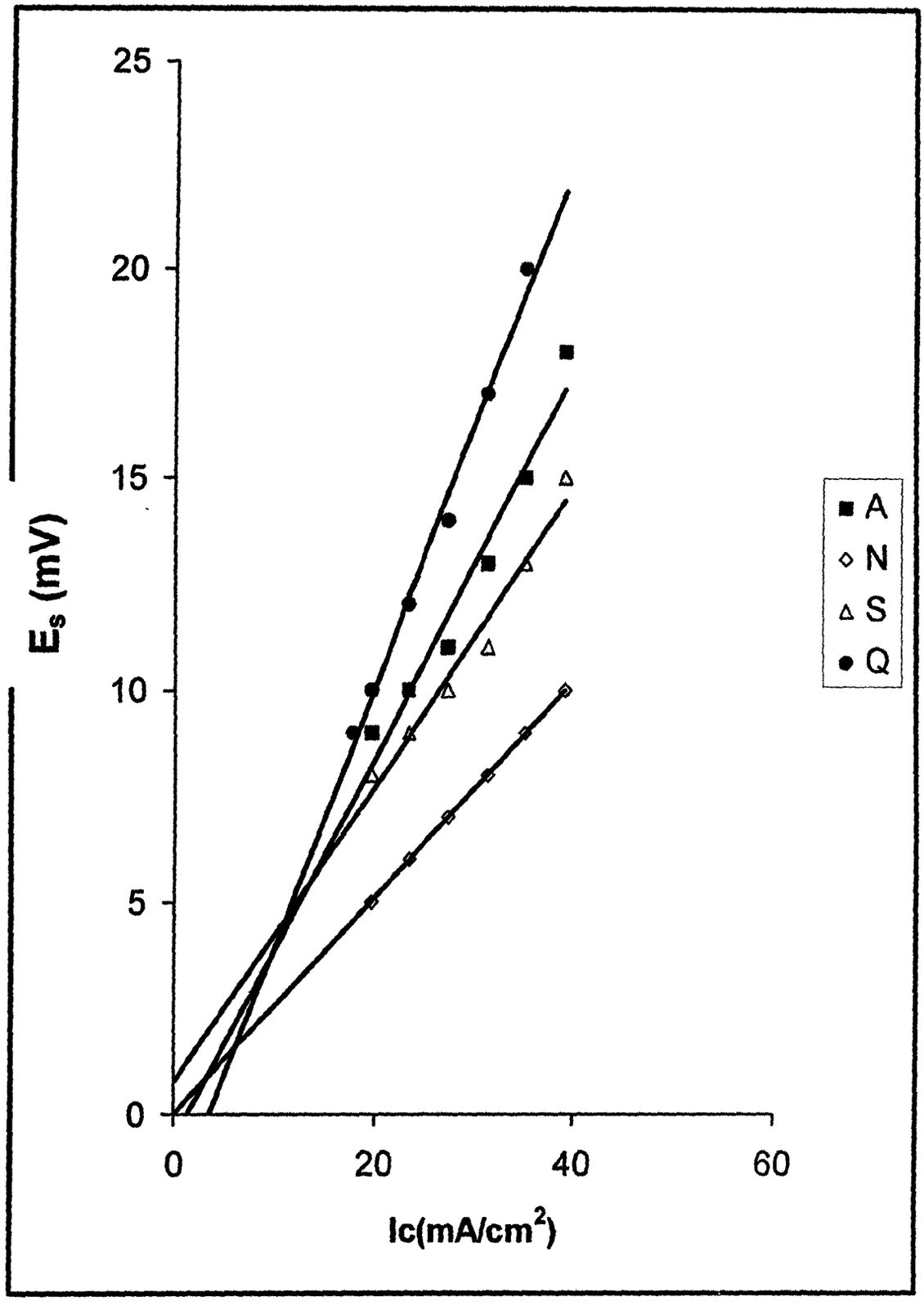
Fig(136): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1 M HNO_3 at 55 °C



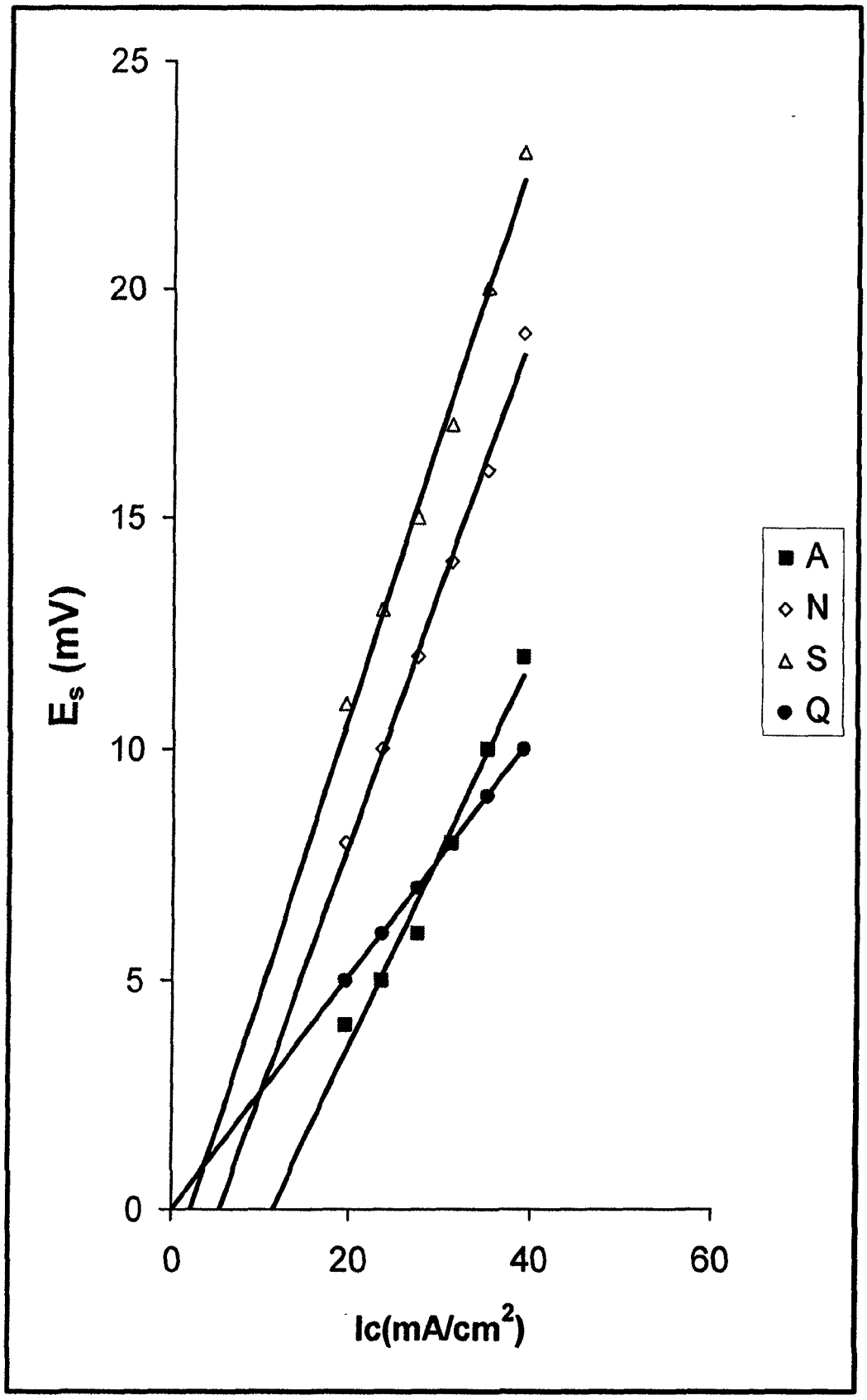
Fig(137): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.3 M HNO_3 at 55 °C



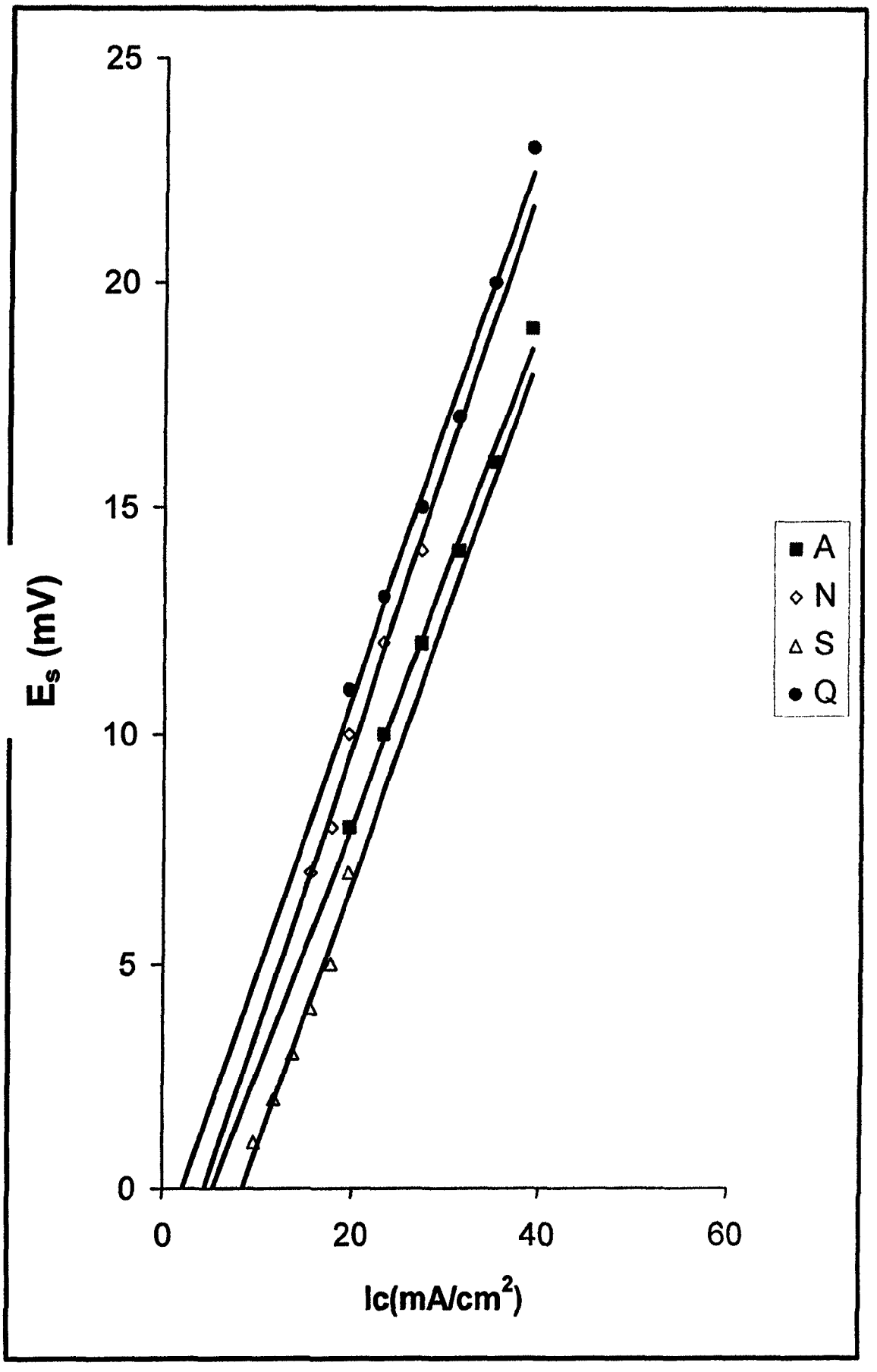
Fig(138): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.5 M HNO_3 at 55 °C



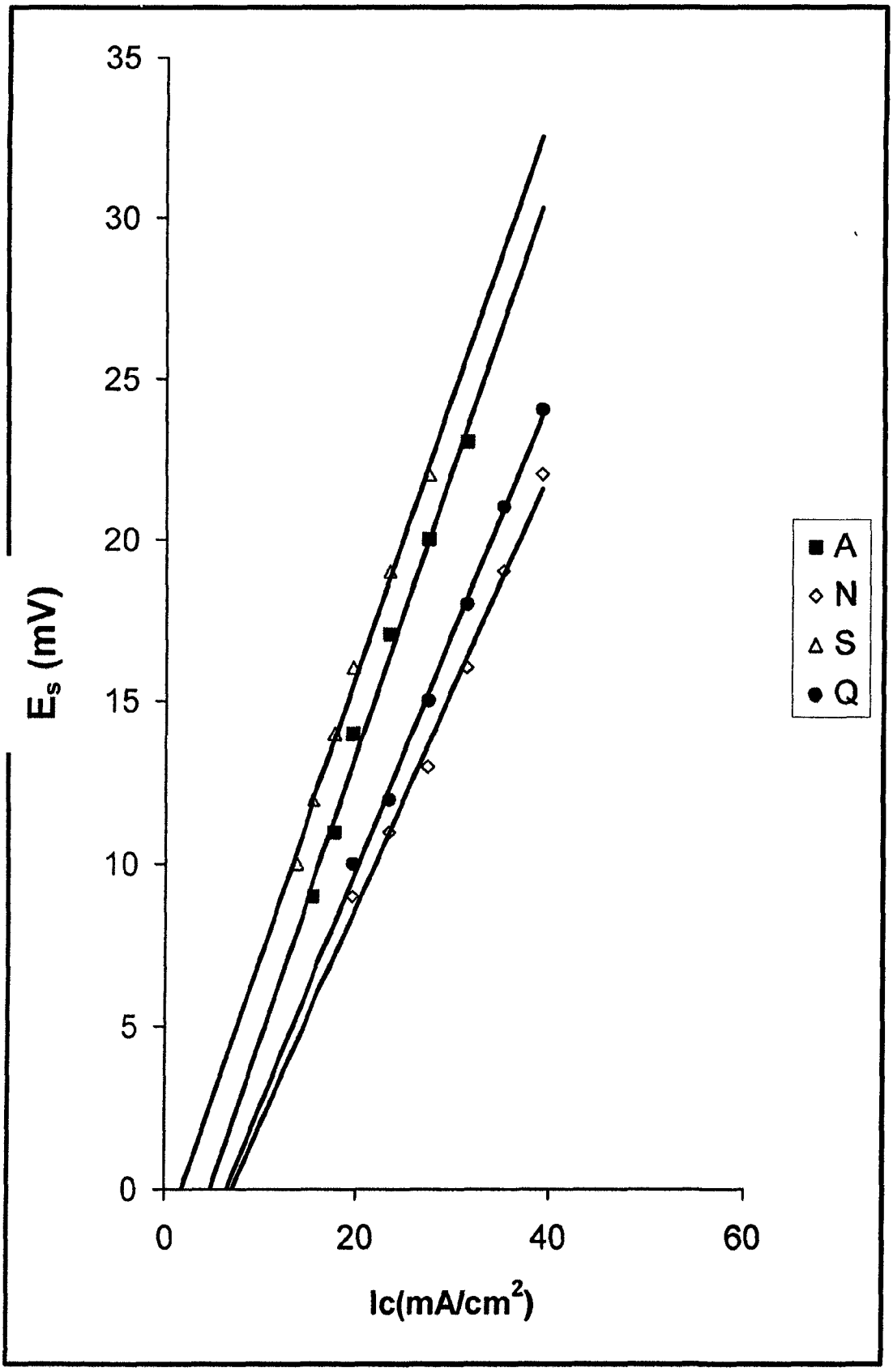
Fig(139): E_s values vs. cathodic current density (Ic)for M.C.V. steel samples in 0.1M HNO_3 at 55 °C in presence of 2 x10^{-5} M HEAA



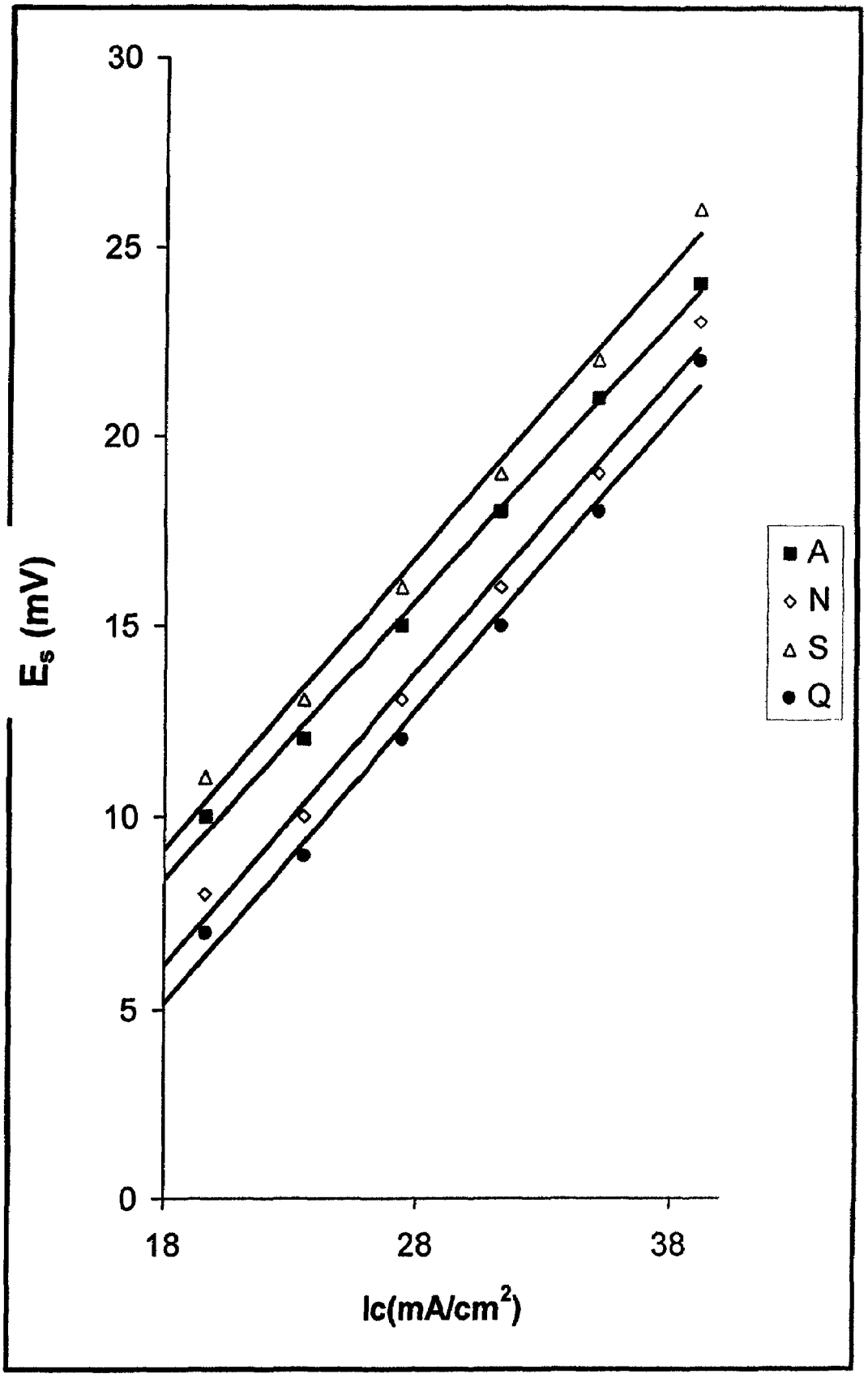
Fig(140): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 55 °C in presence of 4 x10^{-5} M HEAA



Fig(141): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 55 °C in presence of 6 x10^{-5} M HEAA



Fig(142): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 55 °C in presence of 8 x10^{-5} M HEAA



Fig(143): E_s values vs. cathodic current density (Ic)for M.C.V steel samples in 0.1M HNO_3 at 55 °C in presence of 10^{-4} M HEAA

C) Calculations of the Corrosion rates[6-13]

The corrosion rates for all systems, can be determined from the corrosion resistances (it is equal reciprocal of corrosion resistance)[6-13]:

$$\text{Corrosion rate} = \frac{1}{\text{Corrosion resistance}} \qquad (21)$$

The values of corrosion resistances and corrosion rates for all samples under study are recorded in Tables (2-17).

Table(2):Corrosion resistance and corrosion rate for L.C.V. steel samples at different concentrations of HNO_3 at 25 °C.

Sample	$[HNO_3]$ M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.51	1.92
	0.3	0.39	2.51
	0.5	0.36	2.75
N	0.1	0.54	1.82
	0.3	0.45	2.18
	0.5	0.35	2.82
S	0.1	0.53	1.85
	0.3	0.42	2.36
	0.5	0.38	2.63
Q	0.1	0.52	1.90
	0.3	0.43	2.27
	0.5	0.41	2.38

Table(3):Corrosion resistances and corrosion rates for L.C.V steel samples at different concentrations of HNO_3 at 35 °C.

Sample	$[HNO_3]$ M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.45	2.19
	0.3	0.34	2.91
	0.5	0.21	4.77
N	0.1	0.44	2.23
	0.3	0.42	2.33
	0.5	0.25	3.92
S	0.1	0.51	1.93
	0.3	0.41	2.42
	0.5	0.37	2.68
Q	0.1	0.47	2.11
	0.3	0.40	2.48
	0.5	0.22	4.45

Table(4): Corrosion resistances and corrosion rates for L.C.V. steel samples at different concentrations of HNO_3 at 45 °C.

Sample	$[HNO_3]$ M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.38	2.62
	0.3	0.28	3.56
	0.5	0.21	4.58
N	0.1	0.39	2.52
	0.3	0.34	2.88
	0.5	0.16	5.92
S	0.1	0.42	2.32
	0.3	0.32	3.09
	0.5	0.21	4.58
Q	0.1	0.40	2.45
	0.3	0.36	2.70
	0.5	0.18	5.27

Table(5): Corrosion resistances and corrosion rates for L.C.V. steel samples at different concentrations of HNO_3 at 55 °C.

Sample	$[HNO_3]$ M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.42	2.33
	0.3	0.16	5.93
	0.5	0.15	6.35
N	0.1	0.39	2.55
	0.3	0.19	5.07
	0.5	0.18	5.27
S	0.1	0.45	2.18
	0.3	0.27	3.64
	0.5	0.19	5.03
Q	0.1	0.37	2.63
	0.3	0.28	3.54
	0.5	0.17	5.61

Table(6): Corrosion resistances and corrosion rates for L.C.V. steel samples at different concentrations of HEAA in 0.1 M HNO_3 at 25 °C.

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.69	1.44
	4	0.70	1.42
	6	0.72	1.38
	8	0.78	1.27
	10	0.82	1.21
N	2	0.71	1.40
	4	0.73	1.35
	6	0.80	1.24
	8	0.82	1.21
	10	0.86	1.15
S	2	0.74	1.34
	4	0.76	1.30
	6	0.79	1.25
	8	0.81	1.22
	10	0.85	1.17
Q	2	0.72	1.37
	4	0.73	1.35
	6	0.76	1.30
	8	0.82	1.21
	10	0.83	1.19

Table(7): Corrosion resistances and corrosion rate for L.C.V. steel samples at different concentrations of HEAA in 0.1 M HNO_3 at 35 °C.

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.53	1.86
	4	0.55	1.82
	6	0.60	1.68
	8	0.63	1.58
	10	0.66	1.49
N	2	0.54	1.82
	4	0.58	1.70
	6	0.62	1.60
	8	0.65	1.52
	10	0.76	1.30
S	2	0.54	1.83
	4	0.60	1.67
	6	0.63	1.58
	8	0.67	1.49
	10	0.71	1.40
Q	2	0.50	1.99
	4	0.57	1.73
	6	0.64	1.53
	8	0.68	1.46
	10	0.71	1.41

Table(8): Corrosion resistances and corrosion rates for L.C.V. steel samples at different concentrations of HEAA in 0.1 M HNO_3 at 45 °C.

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.44	2.25
	4	0.45	2.18
	6	0.50	1.97
	8	0.67	1.48
	10	0.70	1.42
N	2	0.44	2.25
	4	0.47	2.12
	6	0.60	1.65
	8	0.67	1.47
	10	0.68	1.45
S	2	0.60	1.65
	4	0.63	1.57
	6	0.65	1.52
	8	0.70	1.42
	10	0.71	1.40
Q	2	0.42	2.35
	4	0.44	2.25
	6	0.60	1.64
	8	0.68	1.45
	10	0.70	1.44

Table(9): Corrosion resistances and corrosion rates for L.C.V steel samples at different concentrations of HEAA in 0.1 M HNO_3 at 55 °C.

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.44	2.25
	4	0.47	2.09
	6	0.57	1.74
	8	0.63	1.57
	10	0.65	1.52
N	2	0.47	2.12
	4	0.51	1.95
	6	0.52	1.88
	8	0.60	1.64
	10	0.63	1.57
S	2	0.46	2.14
	4	0.56	1.78
	6	0.64	1.54
	8	0.66	1.50
	10	0.73	1.35
Q	2	0.48	2.07
	4	0.55	1.80
	6	0.64	1.56
	8	0.68	1.46
	10	0.74	1.33

Table(10): Corrosion resistances and corrosion rates for M.C.V steel samples at different concentrations of HNO_3 at 25°C

Sample	$[HNO_3]$ M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.52	1.92
	0.3	0.46	2.17
	0.5	0.41	2.40
N	0.1	0.57	1.74
	0.3	0.48	2.05
	0.5	0.45	2.18
S	0.1	0.57	1.73
	0.3	0.52	1.90
	0.5	0.44	2.24
Q	0.1	0.66	1.50
	0.3	0.49	2.03
	0.5	0.42	2.35

Table(11): Corrosion resistances and corrosion rates for M.C.V. steel samples at different concentrations of HNO_3 at 35 °C

Sample	$[HNO_3]$ M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.48	2.07
	0.3	0.37	2.66
	0.5	0.23	4.31
N	0.1	0.50	1.99
	0.3	0.43	2.32
	0.5	0.32	3.12
S	0.1	0.48	2.06
	0.3	0.45	2.18
	0.5	0.27	3.60
Q	0.1	0.50	1.96
	0.3	0.37	2.63
	0.5	0.32	3.03

Table(12): Corrosion resistances and corrosion rates for M.C.V steel samples at different concentrations of HNO_3 at 45 °C

Sample	$[HNO_3]$ M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.36	2.74
	0.3	0.32	3.03
	0.5	0.16	6.17
N	0.1	0.46	2.17
	0.3	0.24	4.13
	0.5	0.23	4.31
S	0.1	0.38	2.56
	0.3	0.25	3.90
	0.5	0.22	4.48
Q	0.1	0.35	2.86
	0.3	0.32	3.07
	0.5	0.19	5.21

Table(13): Corrosion resistances and corrosion rates for M.C.V steel samples at different concentrations of HNO_3 at 55 °C

Sample	[I]X10^4 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	0.1	0.36	2.77
	0.3	0.27	3.59
	0.5	0.16	6.22
N	0.1	0.38	2.58
	0.3	0.22	4.53
	0.5	0.23	4.25
S	0.1	0.40	2.45
	0.3	0.36	2.77
	0.5	0.28	3.49
Q	0.1	0.34	2.89
	0.3	0.25	3.89
	0.5	0.17	5.57

Table(14): Corrosion resistances and corrosion rates of M.C.V. steel samples at different concentrations of HEAA in 0.1M HNO_3 at 25 °C

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.72	1.38
	4	0.75	1.33
	6	0.79	1.25
	8	0.83	1.21
	10	0.91	1.10
N	2	0.72	1.37
	4	0.79	1.26
	6	0.81	1.23
	8	0.84	1.18
	10	0.94	1.06
S	2	0.73	1.37
	4	0.77	1.30
	6	0.81	1.24
	8	0.86	1.15
	10	0.93	1.07
Q	2	0.74	1.35
	4	0.78	1.28
	6	0.80	1.24
	8	0.85	1.17
	10	0.91	1.10

Table(15): Corrosion resistances and corrosion rates of M.C.V. steel samples at different concentrations of HEAA in 0.1M HNO_3 at 35 °C

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.52	1.90
	4	0.55	1.82
	6	0.66	1.49
	8	0.71	1.40
	10	0.77	1.29
N	2	0.54	1.84
	4	0.63	1.59
	6	0.64	1.56
	8	0.66	1.51
	10	0.70	1.45
S	2	0.52	1.90
	4	0.63	1.57
	6	0.66	1.50
	8	0.80	1.23
	10	0.84	1.19
Q	2	0.54	1.84
	4	0.60	1.67
	6	0.68	1.45
	8	0.71	1.42
	10	0.73	1.35

Table(16): Corrosion resistances and corrosion rates of M.C.V. steel samples at different concentrations of HEAA in 0.1M HNO_3 at 45 °C

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.57	1.74
	4	0.59	1.70
	6	0.63	1.56
	8	0.67	1.49
	10	0.72	1.38
N	2	0.50	1.98
	4	0.59	1.67
	6	0.63	1.56
	8	0.68	1.45
	10	0.74	1.34
S	2	0.51	1.93
	4	0.56	1.77
	6	0.64	1.53
	8	0.70	1.43
	10	0.78	1.27
Q	2	0.54	1.84
	4	0.57	1.75
	6	0.64	1.55
	8	0.68	1.46
	10	0.71	1.40

Table(17): Corrosion resistances and corrosion rates of M.C.V. steel samples at different concentrations of HEAA in 0.1M HNO_3 at 55 °C

Sample	[I]X10^5 M	Resistance Ohm	Corr.Rate Ohm^{-1}
A	2	0.46	2.17
	4	0.54	1.82
	6	0.59	1.68
	8	0.63	1.56
	10	0.67	1.49
N	2	0.47	2.11
	4	0.49	2.05
	6	0.52	1.89
	8	0.63	1.58
	10	0.66	1.54
S	2	0.46	2.14
	4	0.57	1.73
	6	0.61	1.64
	8	0.70	1.43
	10	0.76	1.31
Q	2	0.46	2.14
	4	0.60	1.64
	6	0.63	1.57
	8	0.68	1.45
	10	0.71	1.40