

# ECONOMIC AND STATISTICAL REVIEW OF THE WORLD AND REGIONAL MARKETS OF WELDING MATERIALS

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Electric arc welding is one of the basic technologies of the industrial economy, with the help of which a significant share of GDP in industrialized countries is created. In such countries, one can observe a steady development of welding production — an increase in the consumption of structural materials, appearance of new materials, technologies and equipment for welding at the market. The main structural material for manufacture of welded structures is steel (its share is over 90 %). The state-of-the-art of steel and alloys production largely determines the dynamics of development of welding production. The article presents economic and statistical information on the development of world production and consumption of steel, dynamics of the world market of welding materials, analysis of which allows making the conclusion about the increase in the volume of welding production in the world in the foreseeable future and the growth of demand for welding materials. The growth in consumption of welding materials in the world is largely determined by the rate of development of welding production in China, which is far ahead of other countries and regions in this regard. The development of welding production leads to gradual reduction in the share of manual arc welding and a wider use of semi-automatic and automatic welding. The level of mechanization and automation of arc welding is constantly increasing both in separate countries, as well as in the world as a whole. 8 Ref., 5 Tables, 9 Figures.

**Keywords:** *welding, welding production, structural and welding materials, technologies, steel production, market, state-of-the-art, prospects*

Over the many centuries, welding has proved to be a flexible technology for creating permanent joints, organically fitting into each new spiral of scientific and technological progress. It is impossible to imagine modern civilization without welding and related processes. If all welded, brazed and other permanent joints had suddenly collapsed, humanity would have

remained without most of the machines, mechanisms, devices, communications, transport, energy, buildings and structures.

Electric arc welding in the XX century has become one of the basic technologies of industrial economy. That is the reason for attention paid in the world to the development of welding science and technology.

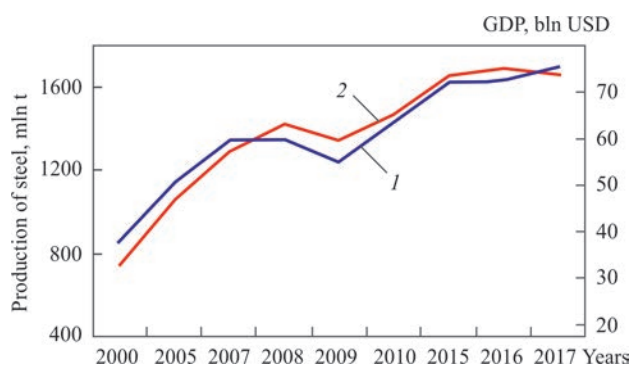
According to the estimates of domestic and foreign specialists, in the foreseeable future, new methods of welding using highly-concentrated heat sources or without melting metal at all are gaining more importance, but, nevertheless, arc welding maintains its leading positions (Table 1).

The main structural materials for welded structures are steel (93–95 %), aluminium, titanium and other non-ferrous metals and plastics (in total 5–7 %), so the development of steel industry is one of the main factors determining the state and dynamics of the development of welding production not only today, but also in the foreseeable future (Figure 1, curve 1). No other material has such a combination of strength, ductility, flexibility and cost as steel. All the produced steel becomes a resource with an unlimited cycle of using and can be recycled.

Despite the fact that steel industry faces a lot of obstacles, such as excessive capacities, volatility of raw and energy markets, risks of protectionist policies, steel keeps on remaining one of the most important materials for the modern economy.

**Table 1.** Prospects for the development of the European market of welding equipment and technologies for the next 10 years

Technological sector of the market	No changes or slight growth	Growth	Significant growth
Consumable electrode arc welding		X	
Nonconsumable electrode arc welding	X	X	
Submerged arc welding or electroslag welding	X	X	
Plasma arc welding	X	X	
Laser welding		X	X
Electron beam welding		X	X
Resistance spot and seam welding	X	X	
Flash butt welding		X	X
Friction welding	X	X	
Ultrasonic welding		X	X
High-frequency welding		X	X
Brazing		X	
Bonding		X	X
Mechanical joining	X	X	



**Figure 1.** Dynamics of steel production (1) and GDP (2) in the world

The production of aluminium (Figure 2) and the consumption of aluminium-magnesium alloys used in aircraft and rocket science have increased.

The scope of application of polyethylene pipes in the construction of most modern networks for different purposes is increasing.

In the world steel production more than 4 mln workers are employed and another 4 mln people are employed in auxiliary industries. The steel production industry is the second largest in the world in energy consumption, despite the fact that energy intensity of its production over the past 30 years has decreased by 50 %. Steel is the engine that provides the development of global industry, and industry indicators reflect the global economic situation [1, 2]. The total influence of metallurgical industry is 2.9 bln US dollars of added value and 96 mln jobs worldwide [3].

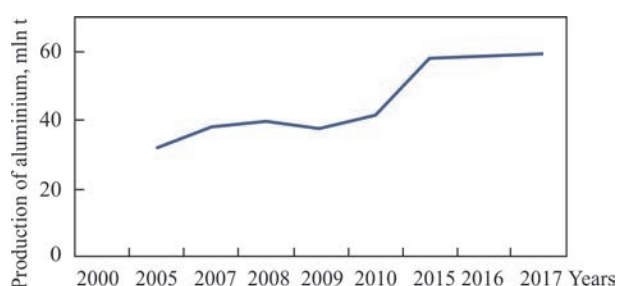
Figure 1 shows close relationship between the world steel production and GDP. Over the past decade, global steel output has increased by 1.7 times and GDP has grown by more than 2 times. On average, for every 100 US dollars of GDP growth it is necessary to produce 2 kg of steel.

The results of 2018 make it possible to consider the forecast of both experts of the World Steel Association (WSA) and the International Iron and Steel Institute (IISI) about the growth by 2025 close to real numbers up to 2.5 milliard t per year of demand for rolled steel and about its average annual growth rate, which will amount to 3.7 % (Figure 3).

According to recently published data of WSA, the world steel production in 2018 increased by 4.6 % as compared to 2017 and amounted to 1.809 milliard t [4]. At the same time, the steel production grew in almost all countries except of the European Union.

In Asia 1.271 milliard t of steel was produced (+5.6 % as compared to 2017), almost 3/4 of steel production of which falls to China, i.e. 928.3 mln t (+6.6 %). At the same time, the share of China in the global production amounted to 51.3 % (in 2017 — 50.3 %).

In India, the volume of production amounted to 106.5 mln t of steel (+4.9 %), which allowed it to



**Figure 2.** Dynamics of aluminium production in the world

become the second steel manufacturer in the world after China, having outstripped Japan, which produced 104.3 mln t of steel (−0.3 %). In South Korea, 72.5 mln t of steel were produced (+2 %).

The steel production in the region of Middle East amounted to 38.5 mln t (+11.7 %). Iran produced 25 mln t of steel in 2018 (+17.7 %), Turkey — 37.3 mln t (−0.6 %).

The European Union produced 168.1 mln t of steel, which is 0.3 % less than the number of 2017. In Germany, 42.4 mln t of steel (−2 %) were melted, in Italy — 24.5 mln t (+1.7 %), in France — 15.4 mln t (−0.7 %), in Spain — 14.3 mln t (−0.1 %).

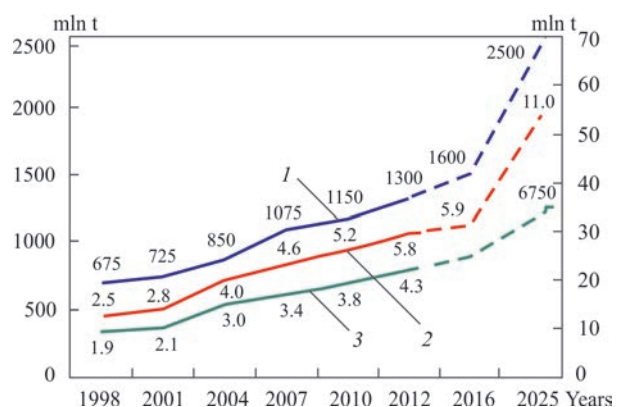
The steel production in North America in 2017 amounted to 120.5 mln t (+4.1 %), of which 86.7 mln t were in the USA, which is by 6.2 % more than in 2017.

The steel production in the CIS region increased slightly (by 0.3 %) to 101.3 mln t. The steel production in Russia amounted to 71.7 mln t (+0.3 %), in Ukraine — 21.1 mln t (−1.1 %).

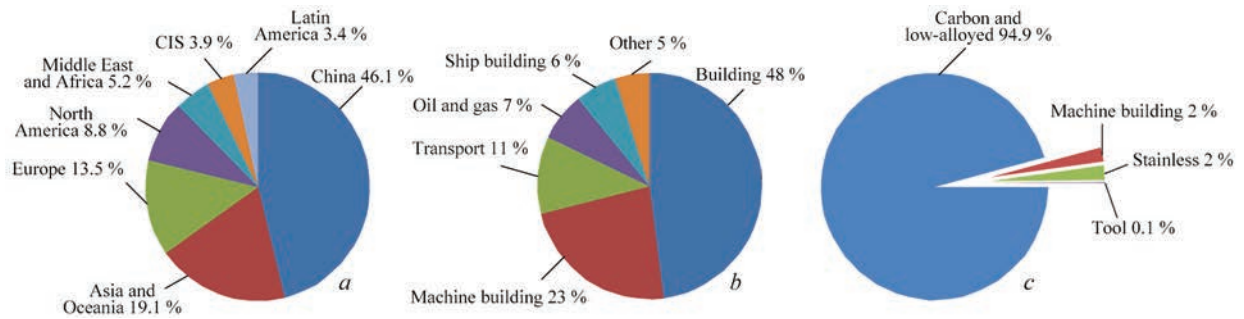
The steel production in South America increased by 1.3 % to 44.3 mln t as compared to 2017, including in Brazil — by 1.1 % to 34.7 mln t.

According to data [4], the highest growth in steel production was noted in Vietnam (+23.2 %), Iran (+17.7 %), Egypt (+13.6 %, at the production of 7.8 mln t), China (+6.6 %), USA (+6.2 %), India (+4.9 %).

Some changes in the ranking positions of the countries, which were the largest steel manufacturers, occurred. Thus, India took the second place instead of the third in 2017, South Korea rose to the fifth place.



**Figure 3.** World consumption of rolled metal (1), welding materials (2) and deposited metal (3)



**Figure 4.** Distribution of world steel consumption by regions (a), industries (b) and structure of consumption by steel grades (c)

Russia is in the sixth place on this list. Iran entered the top 10 steel manufacturers in the world, having outstripped Italy. Ukraine at the end of 2018 is at the thirteenth position, and in 2016 it was at the tenth. Vietnam took seventeenth place, having outstripped Poland and Canada, and came close to Spain in terms of steel production volume.

It can be expected that by 2025 the volumes of metal consumption can reach 2500 mln t and those of welding materials consumption – 11 mln t. As the basis for such an assertion the data can serve, shown in Figure 3, concerning the global consumption of rolled metal, welding materials and the mass of metal deposited during welding for the period of 1998–2012, as well as the abovementioned data on the growth in demand for steel by 2025.

The construction sector will account for 48 % of steel consumption, automotive industry — 11 %, production of technological machinery and equipment (mechanical engineering) — 23 %.

Figure 4 shows distribution of the world steel consumption by regions, industries and steel grades.

The structure of rolled steel consumption by steel grades indicates that 94.9 % of rolled metal is produced using carbon and low-carbon steel, which is the main structural material used in welding.

By 2025, 90 % of the expected growth in steel consumption will be provided mainly by the following industries:

- housing construction, infrastructure projects in the countries with developing economy (68 % of growth);
- technological machine building (13 %);
- oil-gas and other pipes (9 %).

The most striking example, confirming the general trend of the relationship between the growth in steel consumption and the general economic level of countries, having a high growth rate of GDP, is China (Figure 5).

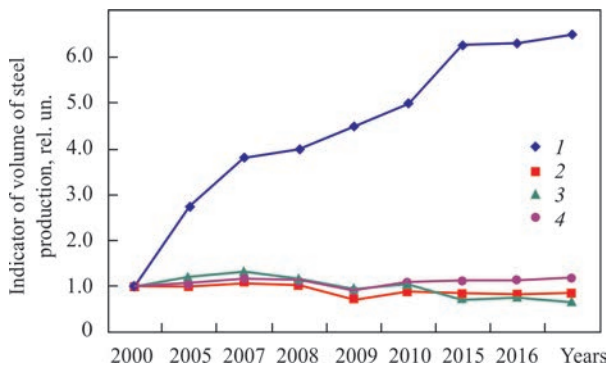
In recent years, China has the highest and most stable growth rate of GDP (8–10 %) and takes the first place in the world in terms of volume and growth rate of steel production and consumption. According to the results of 2018, its share in the world steel production increased to 51.3 %, and in the world consumption — up to 40 %.

For comparison, Table 2 shows data over the past few years on the dynamics of steel production and consumption in the world, as well as on major manufacturers and consumers [5].

In the world scientific and technical literature, two concepts are sometimes confused: «welding materials» and «materials for welding», which leads to misunderstandings when comparing statistical indicators. The first includes materials, the bulk of which forms the composition of weld metal during welding process (for arc welding these are solid and flux-cored wires, coated and other consumable electrodes, fluxes), and the second one is shielding active and inert gases and other materials, including auxiliary, which are involved in providing welding processes.

It can be argued about the attribution of welding fluxes to welding materials, but this is our common practice. Therefore, in the future we will use namely this interpretation of the term «welding materials», although in a number of countries the national statistics takes into account namely «materials for welding», which should be borne in mind when comparing the relevant indicators at the international level.

According to the estimates of ESAB Company specialists, in 2006 the sales value of the global market for welding materials was 45 against 55 % of welding equipment. At present, the sales value of the



**Figure 5.** Production of steel in China, Ukraine and world (indicators of volume of production for 2000 are accepted as one): 1 — China; 2 — EU; 3 — Ukraine; 4 — whole world without China



**Table 2.** Dynamics of production and consumption of steel, mln t

	Production				Consumption			
	2015	2016	2017	2018*	2015	2016	2017	2018
World, in total	1623	1605	1630	1650–1670	1506	1500	1520	1540–1560
Asia <sup>1</sup>	1075	1055	1070	1080–1090	900	1000	1050	1060–1070
China	8004	808	810	790–820	675	645	630	620–650
America <sup>2</sup>	160	155	162	165–175	170	160	165	165–180
USA	80	79	80	80–82	96	95	98	100–102
Europe <sup>3</sup>	200	202	200	198–205	157	196	198	195–200
EU28	169	162	164	162–165	145	155	158	155–160

*Note.* \* — preliminary estimates; 1 — Japan, China, Republic of Korea, Turkey, India; 2 — North and Latin America; 3 — Europe without CIS countries.

world market for welding materials is 60 % of the total market of welding equipment (Table 3).

The annual income of the market for welding materials in 2016 amounted to more than 20 billion US dollars. In the coming years, it is expected to grow and by 2022 may exceed 32 billion US dollars (Figure 6).

Comparing the dynamics of the volumes of markets for welding equipment and welding materials, it should be noted that the market of equipment is more susceptible to ups-and-downs than the market of materials. Therefore, a wide range of companies and enterprises specialized in the production of welding equipment begins to produce welding materials as well. In the coming years, the main drivers for increasing the consumption of welding materials will be the fulfillment of large projects in a number of metal-intensive industries, including:

- power engineering — 9 %;
- ship building — 11 %;
- oil and gas industry — 12 %;
- construction — 20 %;
- automotive industry — 23 %;
- other industries — 25 %.

We usually correlate our data with Japanese data published in the journal «The Japan Welding News for the World» so that we can be sure in their reliability. These data are sufficiently close to the results that we obtain in the course of our investigations. The advantage of Japanese data lies in the wider coverage of regions and, most importantly, in the regularity and efficiency of publication in print (Figure 7).

**Table 3.** Global market for welding equipment (according to the results of 2017)

Region	Equipment, bln USD	Welding materials, bln USD	Total, bln USD	Market share, %
North America	1.7	3.0	4.7	23
Europe	1.6	3.6	5.2	25
Asia	3.4	5.8	9.2	44
South America	0.6	1.0	1.6	8
Total	7.2	12.4	20.7	100

The global consumption of welding materials (Table 4) [6–8], which in 2010 amounted to 5.5 mln t, increased by 4.2 % in 2016 and reached 6 mln t.

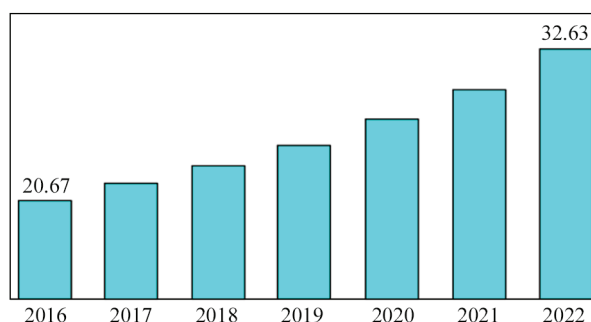
The growth in the world consumption of welding materials was determined, first of all, by the rate of development of China's welding production, which is far ahead of other regions in this respect. In 2016, China accounted for 51.7 % of the total world consumption of welding materials (3200 thou t). The EU countries are far behind — 8.9 % (550 thou t) and North America (USA, Canada, Mexico) — 6.9 % (430 thou t).

From 300 to 200 thou t per year is consumed by Japan (283 thou t), ASEAN (280 thou t), India (270 thou t), Korea (240 thou t), CIS countries (230 thou t), Latin America (210 thou t), Near and Middle East (190 thou t), Africa (150 thou t). This list of regions is closed by Taiwan (80 thou t) and other smaller countries with a total consumption of 70 thou t.

The availability of reliable and complete information on the consumption volumes of welding materials makes it possible to determine the specific structure of fusion arc welding methods used in the world, regions, and in a particular country.

Usually, the mass of the deposited metal is used as a criterion, with the help of which the percentage of manual arc welding with coated electrodes (MAW), welding with a solid electrode wire in shielding gases (CO<sub>2</sub>), flux-cored wire (FCW) and automatic submerged arc welding (AF) is determined.

The information, given in Table 5, indicates that the share of manual arc welding, which in leading

**Figure 6.** Annual income of welding materials market, bln USD

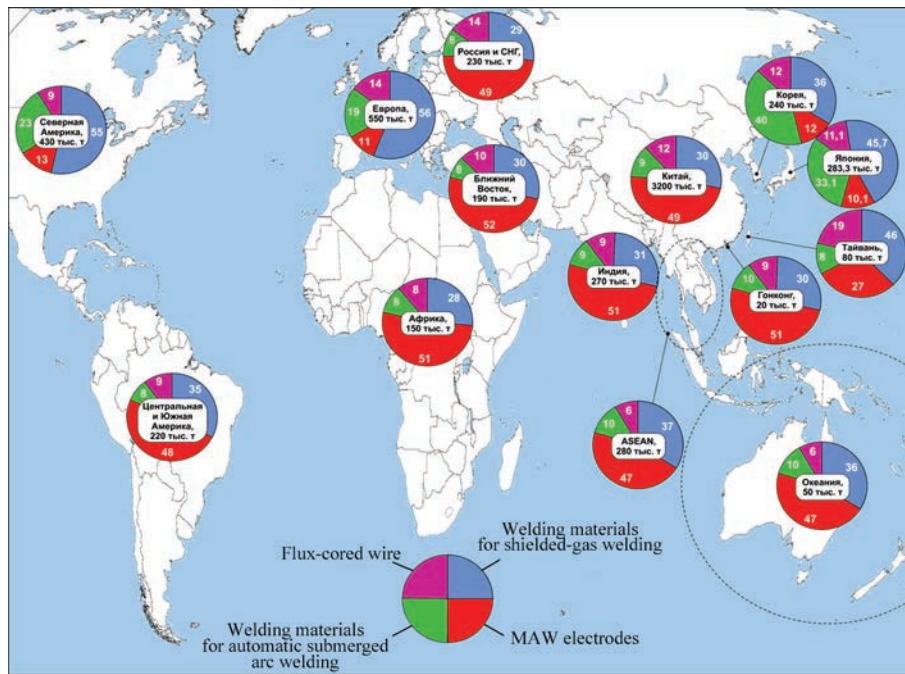


Figure 7. Consumption of welding materials in the regions and countries of the world (2016)

countries amounted to 80–90 % in 1965, decreased in half over 25 years and in 1990 was at the level of 35–45 %.

By then, super optimists of technological progress in welding production insisted that over the next 25 years, the share of manual arc welding with coated electrodes would be practically equal to zero or slightly higher.

In our forecasts, we believed that this welding method will have a right to exist in the foreseeable future, and its share will be about 20 %. As we see, not only super optimists were mistaken in the forecasts, but we also did: today the share of manual arc welding in Japan is 7.3 %, in the EU — 8.9 %, in South Korea — 9.6 % and in North America (USA, Canada and Mexico) — 10.3 %. Globally, the share of manu-

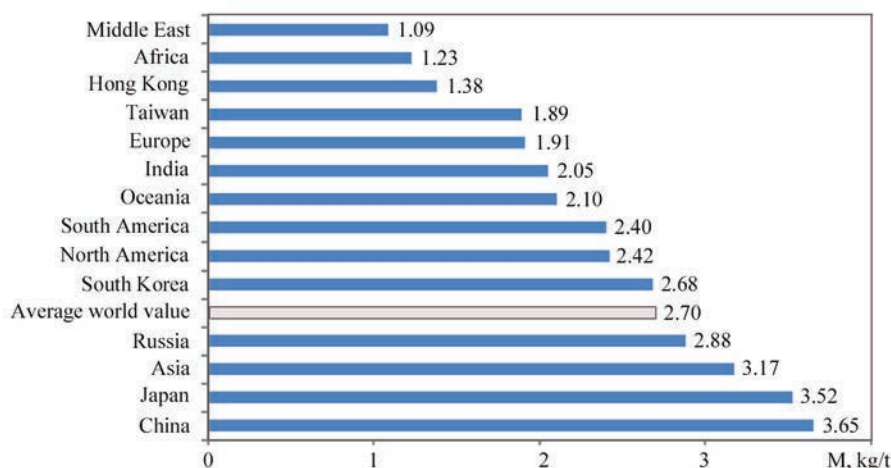
al arc welding is constantly decreasing and currently stands at 33.7 %, mainly due to China (43.7 %), India (45 %), the CIS (44 %) and other countries where the share of manual arc welding is 22–52 %.

The share of welding in shielding gases in the whole world is 44 %. The leaders in using this welding method are EU (63.9 %), USA (61.4 %), Taiwan (54.8 %) and Japan (49.5 %). The leaders in the use of welding with flux-cored wire are South Korea (40 %), Japan (35.9 %) and USA (22.1 %). Globally, welding with flux-cored wire is 14 %.

Automatic submerged arc welding, which worldwide accounts for only 7.9 % of metal deposited during welding, is the most widely used in China (8.7 %) and in the EU (8.1 %). Over the past 40 years, the share of

Table 4. Volume and structure of consumption of welding materials in the main world markets

Region/country	Coated electrodes, %		Solid wire, %		Flux-cored wire, %		Materials for submerged arc welding, %		Total, thou t	
	2010	2016	2010	2016	2010	2016	2010	2016	2010	2016
China	57	40	26	37	6	12	11	11	2 700	2 800
Europe	12	10	56	54	18	23	14	13	540	540
North America	15	11	54	55	22	24	9	10	410	480
Japan	11	9	42	43.5	35	37.2	12	10.3	289	263.4
ASEAN countries	51	42	35	39	8	13	6	6	260	290
Korea	14	11	34	38	40	39	12	12	210	230
Russia and CIS countries	56	45	26	33	5	8	13	14	200	220
India	59	45	26	36	7	10	8	9	250	310
Central and South America	53	44	32	37	6	11	9	8	185	210
Middle East	59	46	26	35	5	9	10	10	160	200
Africa	62	49	25	33	5	9	8	9	130	150
Taiwan	29	25	46	46	18	20	7	9	70	90
Oceania	49	43	36	38	6	10	9	9	50	60
Total									5 474	5 900



**Figure 8.** Regional indicators of mass of deposited metal in welding per one ton of steel M, kg/t

automatic submerged arc welding is almost stable, its fluctuations were: in the EU from 6 to 8.1 %; in the USA from 9 to 6.2 %; in Japan from 9 to 7.3 %.

Figure 8 shows the specific indicators of mass of the metal deposited during welding (kg per ton of steel). These data, taking into account the abovementioned regional indicators of metal consumption and the shares of the used welding methods, allow determining with sufficient level of accuracy the market demand of a particular country (or region) for the welding materials it needs, which, in turn, is necessary for the development of business strategies of companies-manufacturers of welding materials.

In conclusion, it should be noted that in the foreseeable future welding is the basic technology in many industries and in construction. Industrialized countries are characterized by a fairly stable dynamics in the development of welding production and welding market, which is determined by the steady growth in the consumption of structural materials and expansion of their assortment, as well as appearance of new advanced materials, technologies and equipment for welding and related processes on the welding market.

The economic and statistical information on the state and prospects of the development of world production and consumption of steel, the main structural material in the manufacture of welded metal structures, as well as the dynamics of the global market for welding materials allow suggesting that the volume of world welding production will grow in the near future. Accordingly, in spite of temporary crisis phenomena in certain regional markets, the demand for welding materials will grow. The level of mechanization and automation of welding works, which is determined mainly by the scope of application of manual arc welding, is constantly increasing due to a reduction in its share and an increase in the mass of

**Table 5.** Structure of methods of arc welding around the world, regions and countries (% on deposited metal)

Country/region	MAW	CO <sub>2</sub>	FCW	AF
World	33.7	44.4	14	7.9
China	43.7	38.4	9.3	8.7
EU	8.9	63.9	19.1	8.1
USA	10.3	61.5	22.1	6.2
Japan	7.3	49.5	35.9	7.3
India	45	39.4	9.2	6.5
Korea	9.6	43	40	7.5
Russia	44	38.7	7.1	10.3
Ukraine	48.9	32.5	1.4	14.2
Latin America	41.8	30.9	8	6.4
Middle East	46.5	38.5	8.2	7.3
Africa	51.2	36.2	7.1	5.9
Taiwan	21.6	54.8	18.8	5.2
Other	44.4	42.5	7.7	6.8
ACRAN	40.3	45.8	10.1	4.2

metal deposited using semi-automatic and automatic welding in shielding gases, automatic submerged arc welding, as well as with flux-cored wire.

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