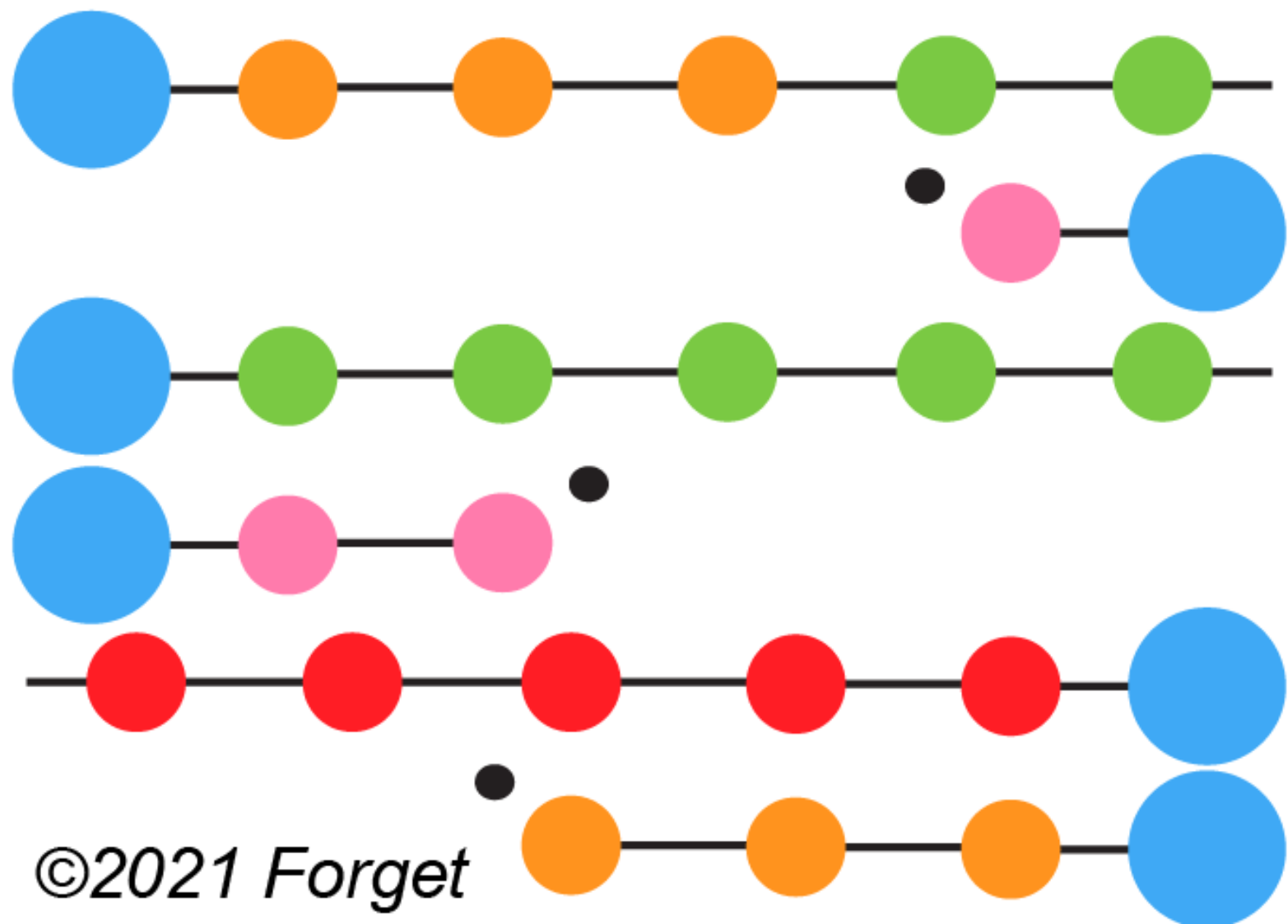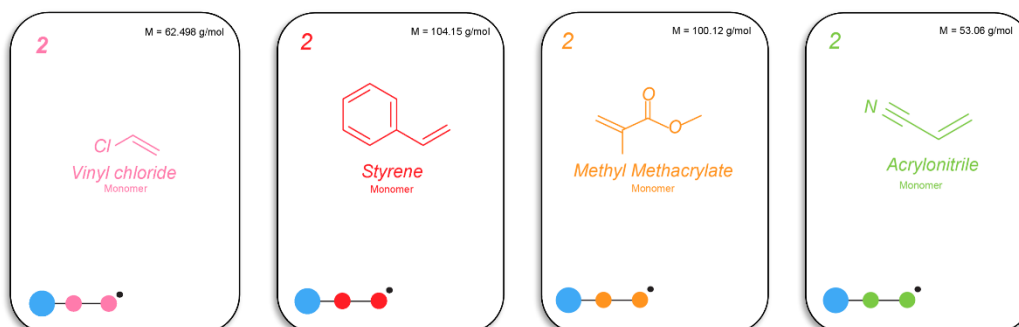# GAME
RULES

GOAL

The aim is to form polymer chains with the higher molecular weight. Only terminated polymer chains are counted. The game stop when one player has empty is hand of cards.
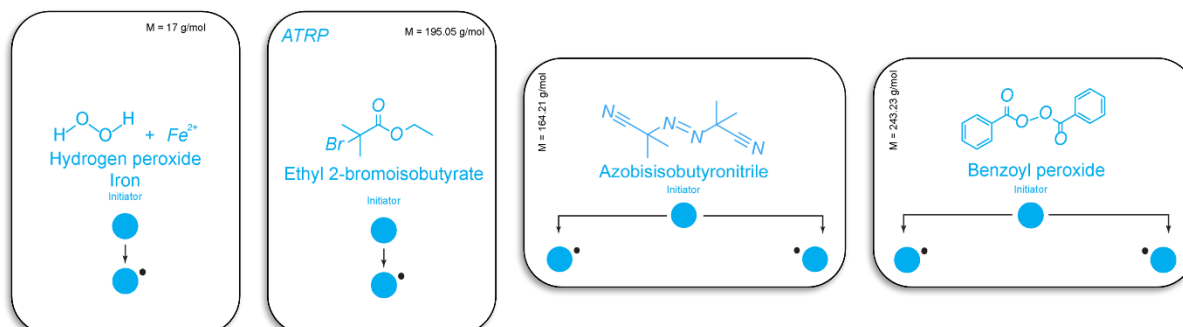
THE CARDS

The set is composed of two card decks each with 55 cards. The decks contain four monomers, four special cards: copolymer, termination, SFRP and CTA. On the card we have a symbol that help remember what the card does for the growing chain, the chemical structure, and the molecular weight of the molecules. Joker cards are Termination, SFRP, CTA and Copolymer.
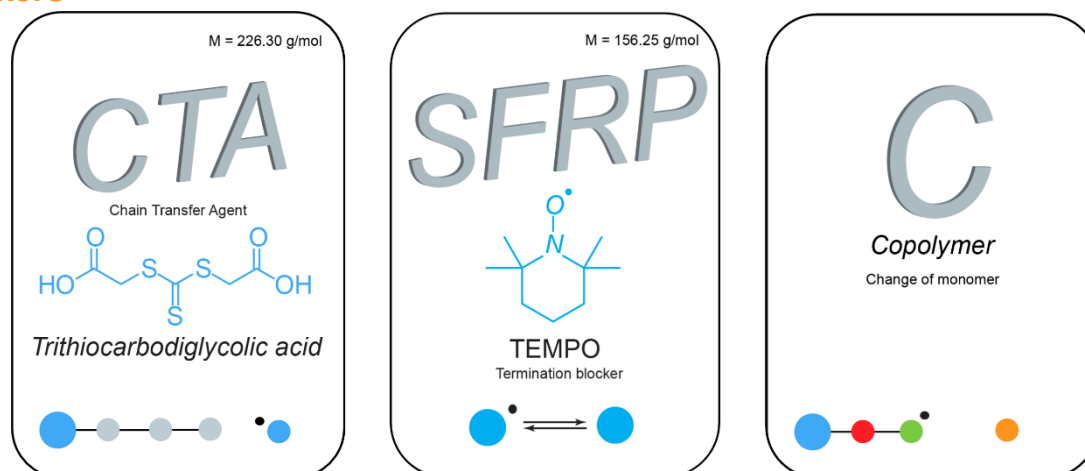
Monomers:

2 M = 62.498 g/mol	**2** M = 104.15 g/mol	**2** M = 100.12 g/mol	**2** M = 53.06 g/mol
Cl —=			N≡
Vinyl chloride	*Styrene*	*Methyl Methacrylate*	*Acrylonitrile*
Monomer	Monomer	Monomer	Monomer

Initiator

M = 17 g/mol	*ATRP* M = 195.05 g/mol	M = 164.21 g/mol	M = 243.23 g/mol
H–O–O–H + Fe^{2+}	Br	N≡ ... ≡N	
Hydrogen peroxide Iron	Ethyl 2-bromoisobutyrate	Azobisisobutyronitrile	Benzoyl peroxide
Initiator	Initiator	Initiator	Initiator

Jokers

|		
M = 226.30 g/mol	M = 156.25 g/mol	
CTA	**SFRP**	**C**
Chain Transfer Agent		*Copolymer*
HO–C(=O)–CH₂–S–C(=S)–S–CH₂–C(=O)–OH	O• (TEMPO)	Change of monomer
Trithiocarbodiglycolic acid	TEMPO	
	Termination blocker	

STARTING THE GAME

Each player starts with 11 cards (4 players), 13 cards (3 players) or 15 cards (2 players). The remaining stack of cards is positioned on the table face down.

- Each turn players take a card from the stack. Then either the player play a round or discard a card face up to form a second stack of cards.
- A player can use a maximum of three cards per round.
- Each round a player can either play with the regular cards or use a joker card.
- Players can use joker cards on its polymer chains or its opponent's chain.
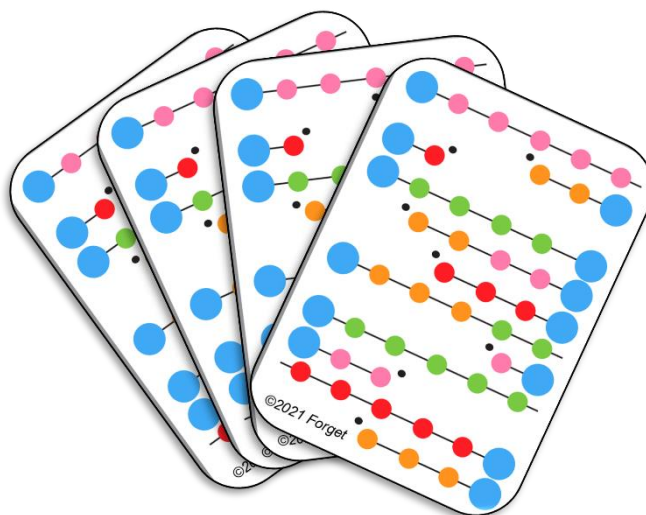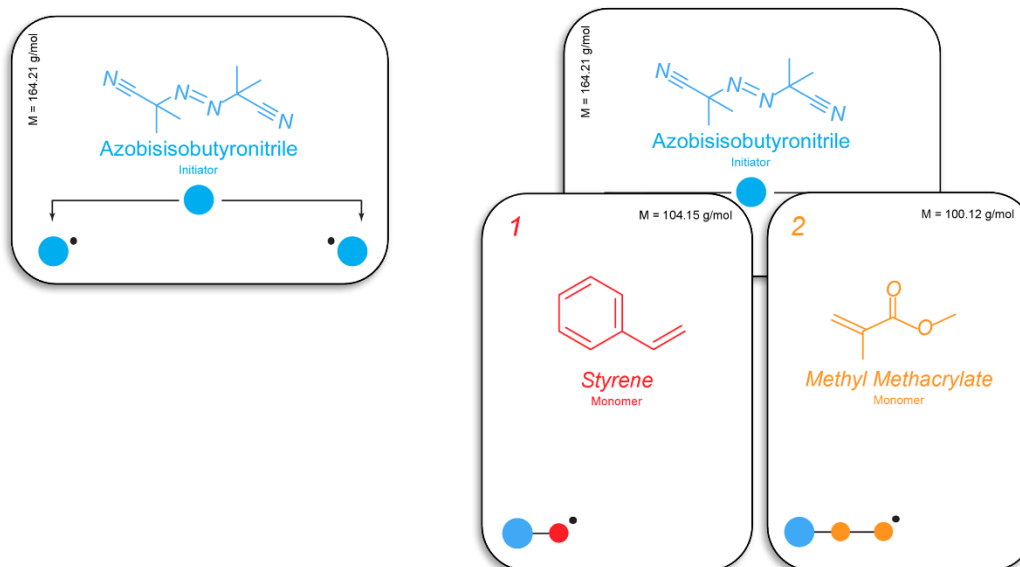

INITIATION

Single radical initiator

To start a polymer chain an initiator is needed. The game start by an initiation phase. To start a polymer chain the player must put on the table an initiator, a monomer and can add another monomer to grow the chain. Giving a maximum of three cards. This is an example with an initiator giving one radical. In one round a player start its chain with the maximum on 3 cards: initiator, monomer with value 1 (radical transfer to a monomer) and another monomer to further extend the chain.
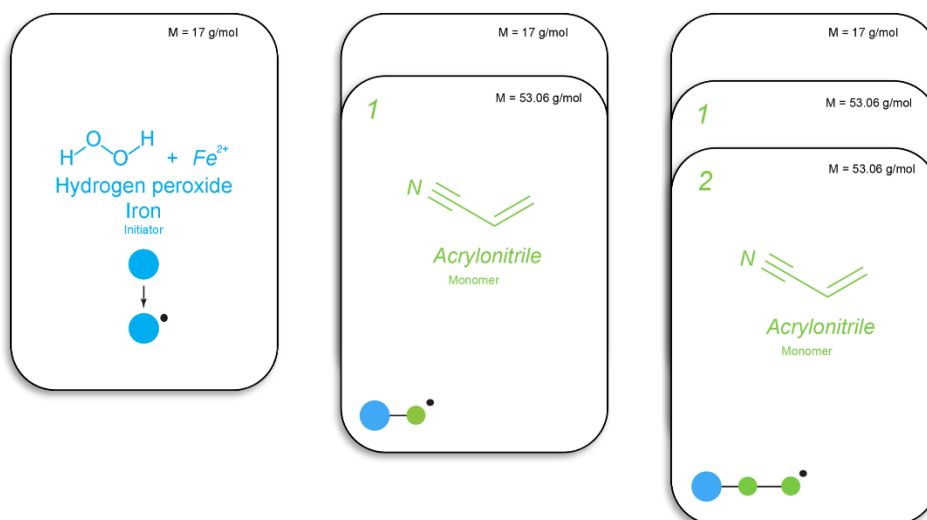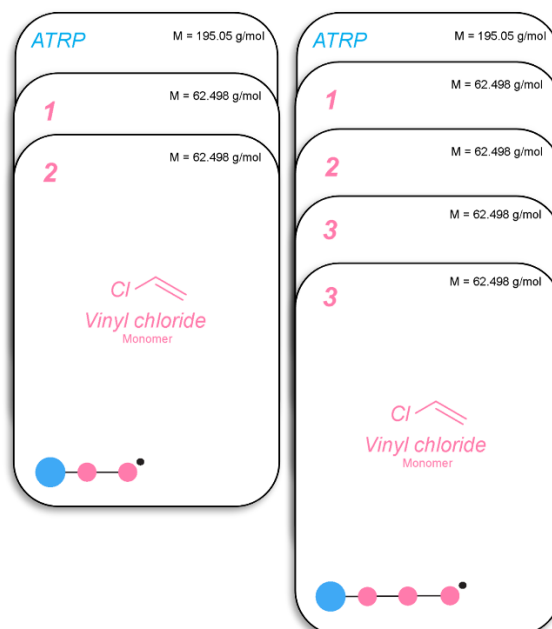
Double radicals initiator

If using a initiator like AIBN, one can start two polymer chains by playing three cards: one initiator and two monomers with the value of one following the rule of three cards per round. The monomers can be the same or two different monomers like in this example.

M = 164.21 g/mol

Azobisisobutyronitrile
Initiator

M = 164.21 g/mol

Azobisisobutyronitrile
Initiator

1   M = 104.15 g/mol

Styrene
Monomer

2   M = 100.12 g/mol

Methyl Methacrylate
Monomer

PROPAGATION

The polymer chain is then grown by adding repeat unit of the same length (1, 2, or 3 as a pair or triplet) or a series (1, 2, 3). Each round a maximum of three cards can be deposited on the table. The chain is grown by simply adding the monomer cards to the chain already started on the desk.

ATRP   M = 195.05 g/mol

1   M = 62.498 g/mol

2   M = 62.498 g/mol

Cl

Vinyl chloride
Monomer

ATRP   M = 195.05 g/mol

1   M = 62.498 g/mol

2   M = 62.498 g/mol

3   M = 62.498 g/mol

3   M = 62.498 g/mol

Cl

Vinyl chloride
Monomer

JOKER CARDS

The cards with grey label are joker cards and can be used on player's polymer chains or opponent chains. The joker cards played on the opponent's polymer chain permits a player to take the polymer chain of the opponent.

Termination cards

Terminated polymer chains cannot be modified and not taken by opponents. Two types of termination: disproportionation giving two polymer chains and combination joining the two growing polymer chains into a single polymer chain. Once a chain is terminated, the number of monomers is counted and added to the players score. The cards forming the chains are put aside. Note that two polymer chains are needed to have termination.

Termination by combination joins two polymer chains into one.
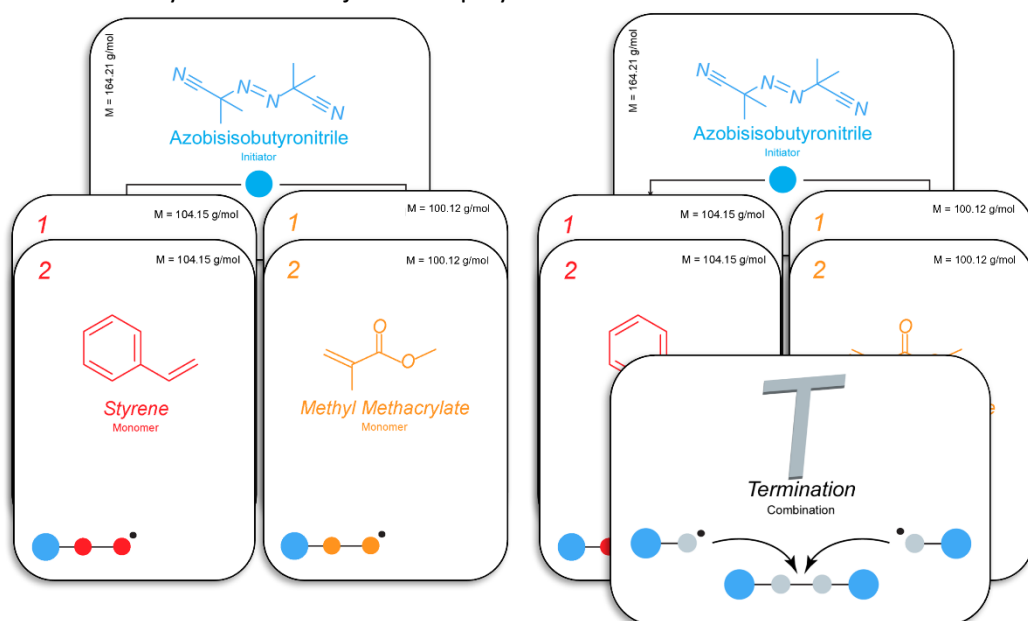
Termination by disproportion gives two polymer chains.
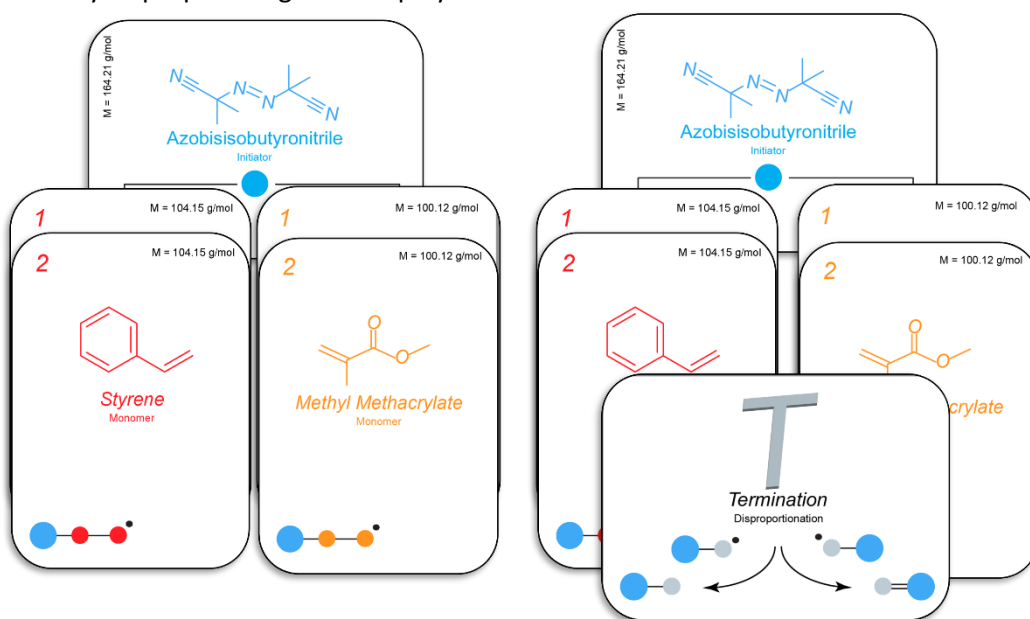
Chain transfer agent (CTA)

Chain transfer agent permits to stop the growth of a polymer chain and to start a new polymer chain without the need for an initiator. Using the CTA will terminate the growth of a chain thus securing the polymer chain from being stolen by the opponent or using the CTA to take the chain of an opponent. On the same round the new polymer chain must by started by providing a monomer with the number one. A maximum of three cards can be used to make this move.
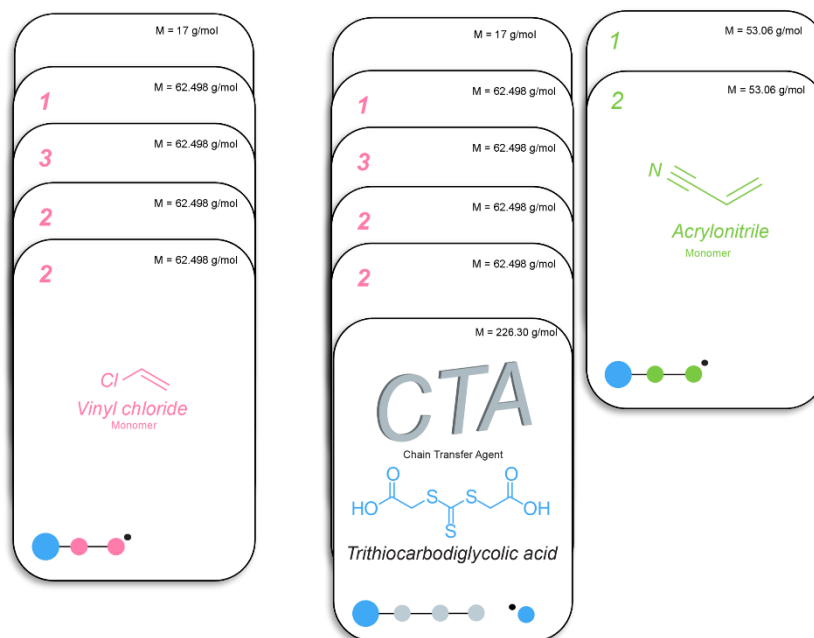
SFRP (TEMPO)

Using TEMPO permits to terminating the growing chain but to reactivated it later on. Using TEMPO secures the polymer chains from being stolen by the opponent. TEMPO must be added as the chain is growing. Only to be used on your own chains.
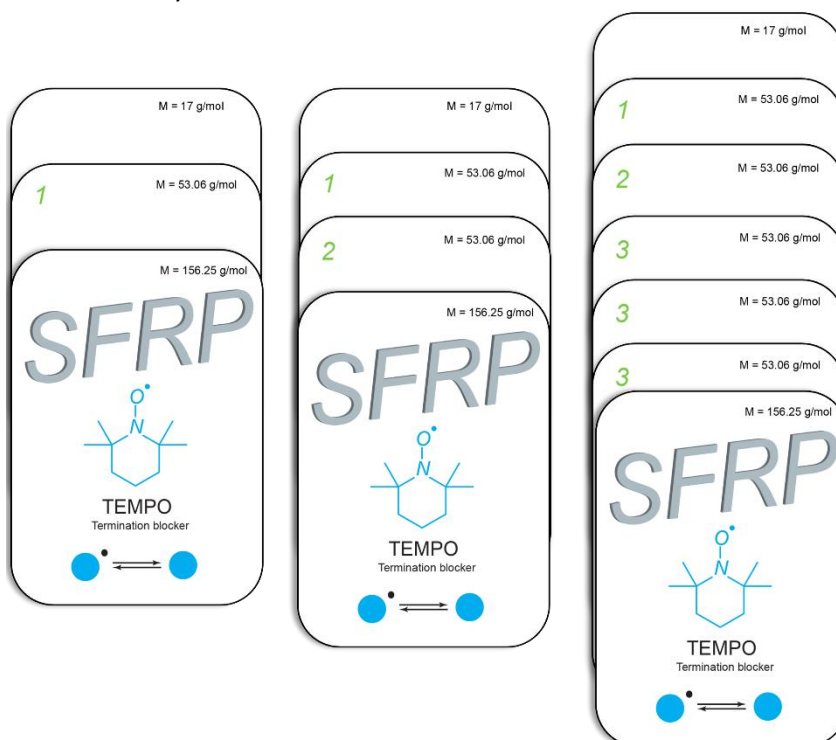
Copolymer

The use of a copolymer card permits to change the monomer used to grow the chain. When using the copolymer card, one must add another monomer to indicate the new monomer to be used to continue to grow the chain. Can be used on one's own chain or on your opponent chain, thus bringing the chain to your side of the table. But this polymer chain is not terminated and can be taken back at the next round.
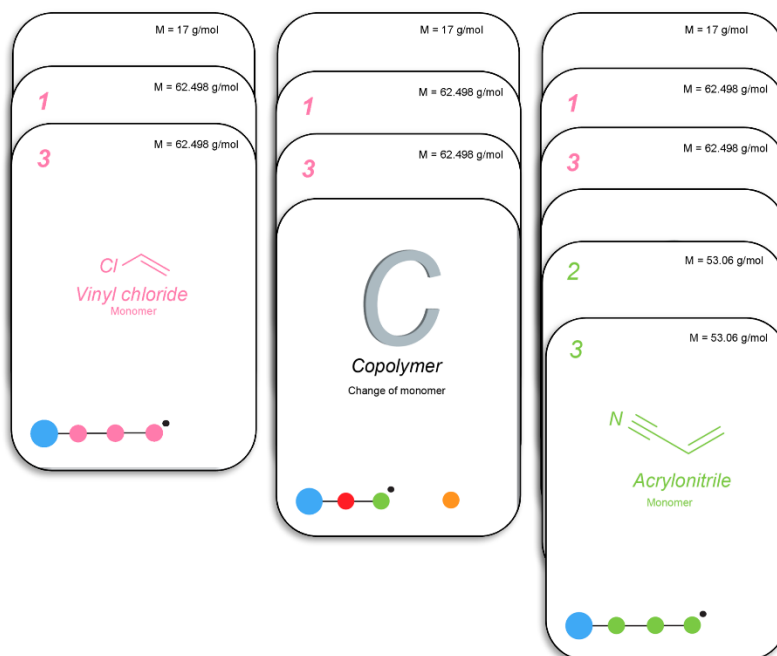
END OF THE GAME

The game ends when one player has emptied his hand.

SCORING

Once the game is finished each player can calculate the length of the polymer chains.
Either by using the number of monomers added to the polymer chains, or by calculating the average molecular weight, weighted average molecular weight and polydispersity index (PDI). The player having the higher Mn and lower PDI has won using the following formulas.

$$M_n = \frac{\sum N_i M_i}{\sum N_i}$$

$$M_w = \frac{\sum N_i M_i^2}{\sum N_i M_i}$$

$$PDI = \frac{M_w}{M_n}$$